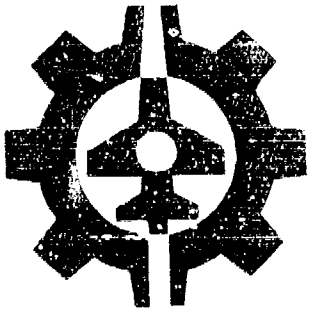

Lifeline in Danger

An Assessment of the United States Defense Industrial Base

The Air Force Association
The USNI Military Database

Published by
The Aerospace Education
Foundation

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Executive Summary

American industry today is unable to expand its production to meet wartime mobilization needs in less than eighteen months. It is not possible to surge the output of even the most important weapons and war materiel much faster than that. The nation has been dependent for years on foreign sources of raw materials. Now it is becoming dependent for critical manufactured goods as well, including some high-technology products that are essential to defense production. Although the United States is still ahead in the international balance of military trade, its relative advantage is declining.

* * *

The United States in 1988 is faced with one of the most fundamental challenges to its leadership of the free world since it assumed that position in the aftermath of World War II. Continuing on its present course, this nation faces the real possibility of becoming a second-rank manufacturing and technology power.

The decline in manufacturing and technology leadership has had a most harmful effect on the nation's defense posture. Along with fears of a *future* loss of technological leadership, the United States must also be concerned about its *current* ability to respond to a national emergency requiring the mobilization of the defense industrial base---those industries that would support the armed forces in time of war or crisis.

Factory closings, the loss of American jobs to foreign competition, and the human toll from unemployment in the nation's "rust belt" have been well publicized. Most Americans, however, remain unaware of the full scope of the problem and its implications. Until recently, even the Department of Defense had not given the problem the attention it demands.

The United States required two years to mobilize its industry for the First and Second World Wars. That was in an era of relative technological simplicity. The World War II mobilization culminated in the legendary "Arsenal of Democracy," which achieved production levels that, in any realistic consideration, would be impossible today. There is serious question whether the United States in 1988 has the capability to support a limited mobilization of significant size or surge production to support its allies. Because of foreign dependencies and other reasons, *domestic industry has difficulty in meeting peacetime, let alone wartime, defense needs.*

This alarming state of affairs has been building for decades. There were danger signals along the way, but few people paid sufficient attention or recognized what the combination of trends portended. The number of firms doing defense work, especially at the supplier and subcontractor levels, has been declining for decades. Many moved to commercial product lines, where they found better profits and less red tape. The demand for high-technology products, along with shrinking defense budgets, made the military a less important customer. Increasingly, markets became driven by commercial demands, not by military considerations, and the international dimension of trade grew more significant.

While Americans worried about a mythical "military-industrial complex," relations between government and the defense industry were deteriorating. Instability in funding and in the defense acquisition process undercut capital investment and productivity. A tangle of laws and regulations, often conflicting with each other, created confusion in the incentives and disincentives to the industrial base.

Critically important research declined. The nation's educational system failed to provide an ample supply of technical manpower. Foreign industries, with significant support and subsidization from their government, began to penetrate U.S. markets. By the 1980s, the United States faced the prospect that it might become dependent---within the next decade---for the high-technology components the armed forces need to maintain their technical advantage in the balance of military power.

A snapshot of the U.S. defense industrial base in 1988 shows a mixed picture. Some industries are still doing well and look ahead to a bright future. Another group, while not threatened at present, is concerned about the future. A third group, which is quite large, is just getting by and scrambling to stay in business. This final group consists largely of the small subcontractors and suppliers who furnish specialty products to the prime defense contractors. Federal programs to assist these industries exist, but they are frequently

insufficient and underfunded.

The matter is further complicated by the need for interoperability and cooperation with allied nations in arms development. In addition, there are compelling reasons to maintain a "two-way street" with those allies in defense procurements. In the past, the United States routinely sold military products abroad, but seldom bought anything of consequence in return. The day of that relationship is past.

o This assessment by the Air Force Association and the USNI Military Database concludes that, for a variety of reasons, **the United States cannot have complete independence for its defense industrial base** and should not try to achieve it. It should, however, move promptly to **reduce its dependency on foreign suppliers** for such critical military components as advanced semiconductors.

o Further, the U.S. should do more to **support domestic defense industry** and promote improvements in its international competitiveness.

o This report also recommends the **appointment of a Presidential Commission** to undertake a wide-ranging, comprehensive analysis of the nation's defense industrial base and to chart a national plan.

o It suggests that large **defense contractors** take a major initiative to **nourish and strengthen the supplier-subcontractor base.**

o Legislative proposals addressing specific parts of the problem abound, but this assessment concludes that hasty action by Congress would be unwise. The proper objective would be to **untangle and rationalize the mass of laws and regulations** that presently exacerbate the problem.

In 1988, the state of the defense industrial base is a heated issue. The problem will not be solved quickly, however. Thus, it is of vital importance that the nation sustain its interest in the problem over time as it searches for a solution that is national in scope, comprehensive, and integrated.

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1. The Problem

The "Arsenal of Democracy" that the United States built to support and sustain the armed forces in World War II is gone. No serious defense professional advocates reconstituting it. The cost and other factors involved in doing so would be insurmountable under the conditions of today. The question, then, is what manner of defense industrial base the nation can and should have instead.

It is clear that the defense industrial base, as it presently exists, is inadequate to a dangerous extent. A steady parade of Department of Defense reports, confirmed in 1980 by a congressional inquiry, warned that U. S. industry could not expand its production to meet wartime mobilization in less than eighteen months. It is still impossible to surge the output of even the most important weapons and war materiel much faster than that.

CHART 1

THE "ARSENAL OF DEMOCRACY"

Aircraft:	296,000
Heavy Bombers	34,400
Medium Bombers	55,500
Fighters	98,700
Major Naval Vessels	1,201
Landing Vessels	64,546
Tanks	86,333
Small Arms Ammunition (Million Rounds)	41,585

War materiel production by U.S. industry from July 1, 1940, to July 31, 1945. This was the legendary "Arsenal of Democracy" that supported and sustained the fighting forces in World War II.

Source: Wartime Production Achievements and Reconversion Outlook: Report of the Chairman, War Production Board, October 9, 1945 (U.S. GPO, 1945), pp. 106-109.

The number of firms doing defense work---especially at the critical supplier and subcontractor level---has been declining for decades. Defense procurement no longer dominates industrial development of high-technology products. The market now is driven by commercial demand, not by military considerations. In July 1988, the Under Secretary of Defense for Acquisition reported that "in many product and process technologies, commercial practice has surpassed defense practice, with the result that the Department of Defense often pays more for less advanced products."[1]

In recent years, new manifestations of the problem have appeared. One of these is that the United States is rapidly losing its leading position in the design and manufacture of electronic components and other high-technology products. If this trend continues, according to a Defense Science Board task force, U.S. military forces will be dependent---within the next decade---on foreign suppliers for critical capabilities needed to maintain technological superiority.[2] The United States has depended for years on uncertain sources overseas for raw materials. Now it is increasingly dependent on other nations for manufactured goods as well. The domestic industrial base is losing its capability to meet defense needs even in peacetime.

These developments have had some stunning side effects---which, to those most directly affected, may appear to be the basic problem rather than a side issue. As the dependency on foreign sources grows and procurements move overseas, the United States loses jobs and business. Japan has gained on the U.S. in the electronics market (see Chart 2), and while the defense trade balance between the United States and Europe is still in our favor, it is declining. (See Chart 3.) Joint international developments and licensing arrangements are increasing. A new challenge on the horizon is the goal of the European Community to establish by 1993 a single, integrated market that some are calling "Fortress Europe."[3]

Meanwhile, concern is growing in the United States about these dependencies, trends in the international economic balance, and the declining competitiveness of U.S. industry. An additional cause for alarm is that the United States does not know how bad its situation is. The July 1988 Defense Department report says that the Pentagon "does not know the extent to which foreign-sourced

parts and components are incorporated in the systems it acquires" and that there "is no reliable system even to identify such dependencies, not to mention systems to minimize them."

CHART 2

JAPAN'S CHALLENGE IN ELECTRONICS

Year	DRAM Generation	No. of U.S. Firms	No. of Japanese Firms
1970	1K	14	8
1974	4K	15	6
1978	16K	12	6
1982	64K	5	6
1985	256K	3	7
1986	1M	3	7

The number of U.S. and Japanese firms engaged in commercial production of Dynamic Random Access Memory (DRAM) chips. As the position of U.S. semiconductor suppliers in the world marketplace has deteriorated in terms of total volume of production, so too has the number of firms capable of producing the most advanced generation of devices at any given time. Of the three U.S. firms now making one megabit DRAM chips, two are captive firms producing principally for their own (essentially commercial) consumption.

Source: Defense Science Board Task Force on Semiconductor Dependency, February 1987.

There are also gaps in what is known about the inability of the defense industrial base to meet surge and mobilization requirements. Gen. Robert T. Marsh, USAF (Ret.), Chairman of the Air Force Association's Science & Technology Committee, has participated in many surge studies. In most cases, he says, the finding was "that all you could really do by way of surge was sort of empty the pipeline. You could push a little faster, up your rates a little bit for things that were already in the pipeline. Then came the big dip, twelve to twenty-four months while the lower tier [supplier and subcontractor] surging took effect."

Moreover, General Marsh says, the surge studies typically have a built-in weakness. They examine only one weapon system at a time. "We never could figure the intersections," he says. "If you're surging AWACS radars and surging Phoenix missiles, we don't know the extent to which they're depending on the same guys for the same critical components."[4] What is certain is that the waiting time for critical system components is long (see Chart 5), and there are few measures at hand to reduce the lead time.

It is a problem with multiple and intertwining roots. A number of the main ones can be identified, though.

1. *The Defense Budget.* Funding for defense has followed an erratic and unpredictable pattern. In general, budgets have been insufficient to cover the requirements indicated by the threat and the national strategy. Instability in the budget and systems acquisition processes makes the defense industry wary of long-term capital investment, which in turn might make it more competitive. As producers shift to commercial product lines, defense becomes a midget in the marketplace, and its needs get less attention than they otherwise might.

2. *Changes in the World Economy.* The trend in defense and many other industries is toward internationalization. The previous independence of the U.S. defense industrial base is unlikely to be regained. The Defense Department claims that one reason that American industry is not as competitive as it should be in the international arena is that many top managers "continue to view the nature of markets as national, not international, and the nature of products as good enough, not world-class." At the same time, the Defense Department acknowledges that "the policies of other governments to subsidize and protect their industries are not matched by the United States government," whose "policies to level the playing field in international trade have been inadequate."[5]

CHART 3

THE DEFENSE TRADE BALANCE

(Billions of Dollars)

European NATO Purchases from U.S.	U.S. Purchases from Europe	Ratio
FY 1982	$2.8	$.9	3:1
FY 1983	8.5	1.0	8:1
FY 1984	7.3	1.2	6:1
FY 1985	4.6	1.6	3:1
FY 1986	3.2	2.0	2:1

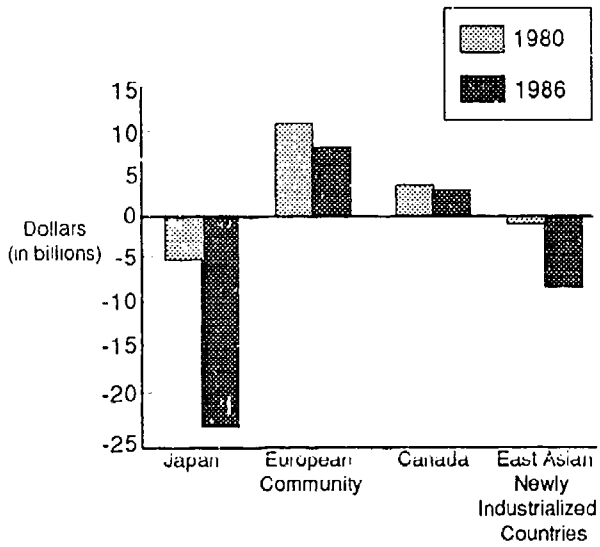
Source: Department of Defense

The United States has nothing close to matching the highly successful Japanese Ministry of International Trade and Industry (MITI), for example. Nor is there a parallel to the Defence Export Services Organization set up by the Ministry of Defence to help British companies. A special office at the British Embassy in Washington exists solely to assist British firms in negotiating the maze of doing defense business in the United States.[6]

U.S. policies have often been attacked as "protectionist," and Americans tend to be sensitive about both the label and the idea it expresses. Other nations---including some that are quick to accuse the United States of protectionism---are less apologetic about trade policies that provide advantages to their own industries.

CHART 4

THE HIGH-TECH TRADE BALANCE



U.S. trade balance with selected nations for high-technology manufactured products. The U.S. high-technology trade balance with Japan has been negative for some time. The deficit of $22 billion in 1986 is almost six times the deficit of 1980. The United States also registered a deficit in high-technology products of $7 billion in 1986 with the newly industrialized countries from East Asia.

Source: International Science and Technology Data Update 1987, National Science Foundation.

3. *Policies in Conflict.* Defense procurement, which is the staff of life for the defense industrial base, is governed by a tangle of laws, regulations, and requirements that often work at cross-purposes to each other and frequently achieve results opposite of those intended. There is no coherent relationship among tax laws, incentives and disincentives in the systems acquisition process, environmental and trade policies, and other aspects of government regulation. Disagreement is possible about where "reasonable oversight" ends and "micromanagement" begins, but by whatever name, activity in this area that is intended to help the defense problem more often worsens it instead. David Packard, who headed the Blue Ribbon Commission that wrote the book on defense procurement reform, charges that competition on major defense contracts typically hangs on "tons of paperwork describing how the bidder would meet a bunch of Mickey Mouse requirements that have absolutely nothing to do with doing the job right."[7]

4. *Requirements in Conflict.* Taken as propositions standing alone, there are valid reasons for the United States to enforce "Buy American" provisions in defense procurement and for it to seek an end to dependence on foreign sources and suppliers. Unfortunately, these goals are in conflict with other objectives that also seem imperative if considered in isolation. It is not possible to reconcile these conflicts completely. The best that can be done is to strike the proper balance.

European allies, for example, say that they will "inevitably need to obtain major weapon systems from the United States, but that a fair balance will not be achieved unless the U.S. in turn buys some of its major weapon systems from Europe."[8]

CHART 5

WAITING TIME FOR COMPONENTS

Engines		Weapons	
Fuel controls -	24	Actuators -	25
Gear boxes -	22	Radomes -	21
Bearings -	23	Traveling wave tubes -	20
Disks -	20	Servos -	18
Fan blades -	19	Microcircuits -	18
Pumps -	16	Harness -	18
Forgings -	13	Warhead -	14
Airfoils -	13	Castings -	7
Castings -	9	Bearings -	7

Aircraft	
Aux. power units -	27
Radar -	27
Avionics -	24
Landing gear -	28
Wheels & brakes -	21
Nacelles -	21
Wings -	27
Actuators -	21
Empennage -	29
Castings -	10
Forgings -	15
Ejection seats -	18

Average lead time (in months) for typical subcontracted aerospace items.

Source: Air Force Systems Command

This is the "two-way street" argument that the allies have been making with some success in recent years. They point out that Europeans have learned to accept interdependence among themselves and that the allied cause is harmed if the United States insists always on selling but is never willing to buy.

Another factor is the need for allied interoperability. Whereas the Warsaw Pact operates a common family of weapon systems, NATO fields a proliferation, which is in the aggregate most costly to acquire and which also leads to less than perfect coordination. Sen. Sam Nunn (D.-Ga.), Chairman of the Senate Armed Services Committee, calls this "structural disarmament." He says that "we as sovereign, independent nations in NATO insist on building our own weapons of every type. We have something like eleven or twelve antitank weapons being built in seven countries. Lord [Peter] Carrington [NATO Secretary General] summarized it well when he said that the only thing NATO allies have in common is the air in the tires of their jeeps."[9]

In recognition of these factors, the Administration and Congress have generally encouraged arms cooperation.

5. *The "Adversarial Relationship."* The popular myth imagines a "military-industrial complex," operating almost as a conspiracy. The fact is that government and industry are well past a sensible "arms' length" relationship, and their dealings are increasingly characterized by hostility and lack of trust. The Defense Department has been zealous---too zealous in the minds of many---in perceiving fraud and criminal wrongdoing. Industry's image is tarnished by the image that results. Sometimes this is fitting, for some perceptions of wrongdoing are valid. The real villain, though, is neither government nor industry but the process. Procurement reformer David Packard says that "in my opinion, the [Defense] Department, the Administration, and Congress together have created an environment in which honest and efficient military acquisition is impossible to implement."[10]

Public opinion plays a part, too. The defense industry constantly must fight a negative image. Most people who bandy about the "military-industrial complex" term are unaware that when he introduced it in his 1961 farewell address, President Eisenhower made it a corollary to his major point that "we can no longer risk emergency improvisation of national defense" and that a strong armaments industry had become necessary to U.S. security.[11]

A recurring point of political folklore in the 1980s is that a considerable amount of the cost of government is caused by waste, fraud, and abuse. This belief does not stand up under scrutiny, but it still persists. By the middle 1980s, this philosophy had put many elements of the Administration into an aggressive, almost hostile, posture toward the defense industry. The zealous effort to uncover waste, fraud, and abuse that ensued brought some wrongdoing to light---but in other instances, it took a tone of vigilante-style "industry bashing."

The so-called "horror stories" about spare parts overpricing have been a staple of the headlines and the evening news. It has been explained repeatedly that real abuses are very much an exception to the norm, that actual spare parts overpricing amounts to a tiny fraction of defense procurement costs, and that in many cases, there is a logical explanation. These observations, however, have not gained much public attention.

There has been an inclination for defense industry to conclude that it cannot win. In 1985, the Navy placed an order with General Dynamics for twelve items, including three gaskets, two bearings, and a pin. The firm computed its cost for the small custom order at $1,300 and decided to give the items to the Navy, waiving its fee to avoid the expressions of public outrage that most likely would have followed.[12]

6. *Lack of Attention.* The defense industrial base problem did not develop overnight, and there were plenty of warning signs along the way. Until recently, few people outside of the professional defense community were paying attention. Even with the present emphasis, no one seems to have a grasp on the entire problem, and specific aspects of it are being addressed in isolation when they are addressed at all.

The solution, to the extent that one is possible, must be national in scope, comprehensive, and integrated. It will not come quickly, and it will not come at all unless the newfound concern about the problem is sustained.

End Notes

[1] Under Secretary of Defense (Acquisition), *Bolstering Defense Industrial Base Competitiveness*, (Washington, D.C., DoD, July 1988).

[2] Defense Science Board, *Report of the Defense Science Board Task Force on Semiconductor Dependency* (Washington, D.C., Office of the Under Secretary of Defense for Acquistion, February 1987).

[3] Stephen P. Aubin, "An Industry Without Frontiers," forthcoming, *AIR FORCE Magazine*, October 1988.

[4] John T. Correll, "The Uncertain Lifeline," *AIR FORCE Magazine*, June 1988.

[5] *Bolstering Defense Industrial Base Competitiveness, op.cit.*

[6] F. Clifton Berry, Jr., "The British Are Coming," *AIR FORCE Magazine*, June 1987.

[7] David Packard, testimony to the Senate Armed Services Committee, July 27, 1988.
[8] The Rt. Hon. Neville Trotter, M.P., "The Protectionist Wedge," *AIR FORCE Magazine,* December 1983.
[9] John T. Correll, "Why NATO Needs a Conventional Defense," *AIR FORCE Magazine,* August 1987.
[10] Packard, *op.cit.*
[11] Russell E. Dougherty, "What Ike Really Said," *AIR FORCE Magazine,* October 1983.
[12] John T. Correll, "Industry Under the Gun," *AIR FORCE Magazine,* November 1985.

2. A Review of Industrial Mobilization

Three times in the last seventy-five years the United States has mobilized its industrial might in the cause of national defense. On two of these occasions, the Great War of 1914--18 and, some twenty years later, the Second World War, America also provided massive quantities of weaponry and supplies to sustain the war efforts of its allies, in addition to its national requirements. In the third instance, the U.S. undertook a massive mobilization of its resources in the belief that the police action in Korea presaged a major war with the Soviet Union and its allies. In each case, the U.S. economy was converted from almost purely civilian production, with little military manufacturing capability, into an "Arsenal of Democracy" capable of supplying the enormous military needs of itself and its allies.

On one other occasion in this century the United States has fought a war requiring large quantities of weapons and supplies, both for its own forces and those of an allied nation. Because of domestic political considerations, however, the industrial base was never mobilized during the U.S. involvement in Vietnam; instead, reliance was placed on reserve stocks and limited surges in selected industries.

World War I

The United States' entry into World War I began well before the formal declaration of war in April 1917. For several years prior to that, the United States had been selling arms and other war material, as well as providing credit to finance these purchases, to the Entente Powers (Great Britain, France, and Russia) in their costly struggle with Germany and the other members of the Central Powers. This had the effect of firmly linking America with the Entente and prompting the eventual U.S. entry into the war. It also provided a strong stimulus to the fledgling, prewar U.S. armaments industry, causing growth in several sectors, primarily in the manufacture of small arms and ammunition. But when the time finally came for the United States to arm itself, the United States government found itself forced to acquire the majority of its heavy weapons from Britain or France. U.S. armaments industries, in spite of the massive amounts of money funnelled into them during the course of the war, were simply unable to provide even a fraction of the needed weapons before the war ended.

As mobilization began in 1917, the government ordered 50,000 artillery pieces, along with the requisite stocks of ammunition, from U.S. industry at a cost of $4 billion. Of these, *only 143* pieces were finished in time to be used on the battlefield.[1] The same story applied to U.S. aircraft squadrons; throughout the war the U.S. services flew only French- and British-designed and -built aircraft in combat.

One of the few areas where U.S. industry did mobilize relatively well was in shipbuilding. Prior to the war there were sixty-one shipyards in the U.S., but by 1918 there were 341 yards *producing more than 400,000 deadweight tons per month.* On one day, July 4, 1918, these yards delivered more seagoing ships than had ever been launched in America during a single year.[2] Even with these impressive gains in production, however, output never reached a level commensurate with combat requirements, and most of the ships ordered, both combatant and merchant, were not delivered until after the Armistice was signed.

The principal reason for the failure of U.S. industry to meet the needs of the armed forces was a lack of prewar government planning. In the first months after the declaration of war in 1917, the U.S. armed services flooded industry with requests for equipment of all kinds. The result was utter chaos. U.S. industry was already producing at close to full capacity in response to orders from Europe and the general prosperity at home. Furthermore, no early efforts were made to curtail nonessential civilian production. Because of this lack of coordination, critical materials were often unavailable where and when they were needed, causing lengthy delays in the production of even the most basic goods. Along with these bottlenecks came transportation shortages and galloping price inflation.

After much confusion, the federal government stepped in and established a Preference Rating System of priorities that put military goods ahead of civilian and categorized military items by importance. In addition, a host of new agencies was established to help coordinate the war effort; these included the War Industries Board; the Food, Fuel, and Railroad Administrations; the War Trade Board; and the National War Labor Board. Despite herculean efforts, the industrial base was never able to make up for the lack of prewar preparedness and planning before the signing of the Armistice in November 1918.

Armistice to Pearl Harbor

Following the war, in an effort to avoid any repetition of the debacle of 1917, Congress passed the National Defense Act of 1920, charging the Assistant Secretary of War with laying the groundwork for future industrial mobilizations. Three significant agencies were subsequently constituted to comply with this mandate: the Army Industrial College (today the Industrial College of the Armed Forces), the Planning Branch within the Office of the Assistant Secretary of War, and the Army and Navy Munitions Board.

The goal of the Army Industrial College was to train officers in procurement and industrial mobilization practices, while the Planning Branch concentrated on procurement planning; both eventually carved out a niche in mobilization planning. Unlike the other two Army agencies, the joint Army and Navy Munitions Board was to be the nation's principal agent in preparing mobilization plans. In accordance with this charge, it produced a series of Industrial Mobilization Plans (IMPs) in 1930, 1933, 1936, and 1939. Although many of the major premises behind these plans were flawed in that they failed to consider important aspects such as the necessity of supplying allied forces and the domestic political complications involved in mobilizing industry, the planning *process* nevertheless provided U.S. planners with valuable experience in designing an industrial mobilization plan, however flawed in reality.

World War II

During the late 1930s, the United States was once again drawn into a European War. Perhaps not surprisingly, its path from bystander to belligerent was in many ways similar to its World War I experience. The Allies, especially after the fall of France in 1940, came to the United States seeking credit and military supplies to equip their beleaguered forces. American industry, ever reluctant to abandon its profitable commercial markets but exhorted by President Franklin Roosevelt, began to expand its military production capabilities to produce equipment for the reeling Allies, a move that would later benefit the United States when it was dragged into the war after Pearl Harbor. However, this unforeseen prewar military expansion would also serve to pull the rug out from under the established Industrial Mobilization Plan.

In addition to foreign purchases, U.S. industry also began to receive U.S. government orders for weapons and equipment to supply the forces generated by the federalization of the National Guard and the first peacetime draft in U.S. history. All of this activity was at variance with the preordained IMP, which was based on the concept of an "M-Day," the day upon which the country would begin to mobilize for war, and made no exceptions for an ad hoc, somewhat haphazard, prewar military buildup.

The result of these uncoordinated premobilization orders was an almost immediate shortage of certain goods along with all of the mobilization-related problems, such as wage and price inflation and backlogs, encountered in the First World War. A simplistic Preference Rating System, administered by the Supply Priorities and Allocations Board, was established even before Pearl Harbor to relieve these pressures but was soon overtaken by events that rendered it ineffective.

Initially a rating system of categories A-1 through A-10 was established, with an "AA" reserved for "extreme" emergencies. Almost immediately orders began to suffer from "rating inflation," in which all orders' ratings escalated to the highest level. To resolve this problem, category A-1 was further divided into ten different categories, five separate "AA" categories were established, and an "AAA" category was set up for extreme emergency orders. Perhaps the greatest early handicap, however, was that until December 1941, participation in the system was entirely voluntary.

In an effort to coordinate this unprecedented rearmament, the civilian Office of Production Management was set up. It favored a conservative approach to industrial mobilization, reflecting the views of its leaders, all of whom were hired from American industry, many as "dollar-a-year men" who remained on their companies' payrolls. Prior to 1941, industry was hesitant to expand military production, fearing it would curtail commercial operations only recently recovered from the Great Depression. Moreover, there was no guarantee that the United States would ever enter the war, an event needed to assure the profitability of their investment in new defense-related production capacity. This refusal to reduce civilian production helped to further slow the early development of a U.S. wartime industrial base.

When the nation was thrust into the war following the attack on Pearl Harbor, the Roosevelt Administration quickly moved to establish an "alphabet soup" of temporary wartime agencies to control all aspects of the national mobilization. These included the War Production Board (WPB), intended to act as an overseer of all war production issues; the Office of Price Administration (OPA), to control inflation, wages, and the cost of living; and the Office of War Mobilization (OWM), established in 1943 to supersede the WPB, which, along with its director, Donald Nelson, was deemed too weak to carry out its mission. (The OWM director was soon nicknamed the "Assistant President" and wielded

more power than did many cabinet members.) As in any situation with power of such magnitude at stake, there was much internecine combat among agencies over who would control which aspects of the mobilization. These skirmishes also took their toll in efficiency and overall industry coordination.

Because of the haphazard and seemingly random way in which the wartime agencies were created, their ultimate roles evolved over time. None sprang directly from any of the Army and Navy Munitions Board's prewar mobilization studies, although many agencies were inspired by concepts pioneered in these early forays into mobilization planning. This gradual evolution gave the mobilization effort an improvised "feel" and, in fact, resulted in many mistakes and untold frustrations. On reflection, however, many mobilization experts have praised it as being the most effective way in which the system could have met rapidly changing wartime requirements. The best solution would, of course, have been a comprehensive, detailed, but completely flexible prewar plan to coordinate all aspects of the domestic mobilization effort from the start. Unfortunately, political realities made (and continue today to make) such an instrument highly unlikely---a bureaucratic chimera.

Perhaps the clearest perception that the average American has of the mobilization period is President Franklin Roosevelt's "Arsenal of Democracy" concept, the reality of which has long since passed into a semi-myth in which automobiles stopped rolling off the assembly line one day and airplanes came off it the next. While this perception is very useful in characterizing the nature of the conversion process, it obscures the reality. Even with the immediate prewar expansion of the defense industries, it was not until mid-1943 that the United States began to reach its peak production levels in many crucial war industries. This almost two-year period that was required to mobilize fully mirrored the earlier experience of World War I. Had World War I continued, U.S. industry would have been producing at peak capacity in 1919, roughly two years after the nation's entry into the conflict.

Much of the blame for the World War II failure to reach production peaks earlier is focused on bottlenecks in the production of vital equipment and raw materials needed to expand the capacities of other facets of the economy. Most important were the shortage of machine tools for manufacturing and construction equipment for building new production facilities. Many raw materials were also in short supply, including basic metals like copper, steel, and aluminum, and were brought under the Controlled Materials Plan for priority distribution.

A shortage of skilled labor further complicated America's mobilization in the early months of the war, as did discrepancies between the location of new factories and the location of adequate sources of labor. Many plants were built in areas already heavily industrialized and having little surplus labor, instead of being situated in regions with abundant manpower.

Despite the many improvisations required and the seemingly endless "turf fights" over authority, the U.S. mobilization effort was extraordinarily successful. By 1944, with the beginning of the end in sight, it was apparent that the U.S. would not need all of the industrial capacity it had mobilized. The war effort was by then absorbing forty-four percent of America's GNP, up dramatically from a mere two percent in 1940, and even more capacity was available.[3] This figure subsequently dropped to thirty-nine percent during 1945 as the war drew to a close.[4] By war's end, the government had built 1,600 new plants for the then inconceivable sum of $12.7 billion and financed private expansion of others costing an additional $6 billion.[5]

Korea and the Cold War

Almost immediately after the destruction of Hiroshima and Nagasaki ended the Second World War, the U.S. began a military build-down on an unprecedented scale. The machine tools so desperately produced during the war were sold off at fifteen cents on the dollar, and many of the factories built during the war were also sold at ridiculously low prices or allowed to deteriorate through lack of maintenance. The "fire sale" on machine tools had a disastrous effect on the industry. By 1951, U.S. machine tool production capacity had fallen to one-third of its 1941 levels, with thirty-four companies closing due to lack of business alone.[6] Active military forces were also reduced to the bare minimum.

The newly perceived threat of the Soviet Union, however, prompted Congress and the Administration to establish several programs to pave the way for future mobilizations. The Strategic and Critical Materials Stockpiling Act of 1946, forerunner of the current National Defense Stockpile, established a reserve of militarily important materials likely to be in short supply during a war or national emergency. As part of the National Security Act of 1947, which created the Department of Defense and established the Air Force as a separate service, a National Security Resources Board (NSRB) was established to coordinate long-range military, industrial, and civilian mobilization efforts. In addition, the act formalized the role of the prewar Munitions Board, reestablished in 1946, in planning the short-term aspects of military mobilization and procurement. Other legislation passed during 1947--48 laid the framework for protecting critical

industries and maintaining reserves of machinery, facilities, and tools necessary to augment production during a crisis.

The outbreak of the Korean War on June 25, 1950, found the U.S. armed forces woefully unprepared and the nation's industrial base unready to support the expansion needed to carry on the war effort. Three months after the war began, Congress, in response to President Harry S Truman's request for legislation to promote industrial mobilization and restrain inflation, passed the Defense Production Act (DPA) of 1950. The DPA contained seven titles, summarized in Chart 6, giving the President unprecedented authority to mobilize the economy.

Unlike Roosevelt, President Truman planned to conduct the mobilization using the NSRB and other existing agencies instead of creating temporary ones. Events in Korea, however, forced his

CHART 6

THE DEFENSE PRODUCTION ACT

	TITLE	PROVISIONS	STATUS
I.	Priorities and Allocations	- Priority contract performance - Allocation of materials - Prevention of hoarding - Agricultural product restrictions	- In effect - In effect - In effect - Added 1951, repealed 1953
II.	Requisitioning/ Condemnation	- Requisition - Condemnation	- Repealed 1953 - Added 1951, repealed 1953
III.	Expansion of Productive Capacity and Supply	- Purchase agreements, loans and loan guarantees, installation of equipment - Treasury borrowing authority to finance project	- In effect - Repealed 1974
IV.	Price and Wage Stabilization		- Repealed 1953
V.	Settlement of Labor Disputes		- Repealed 1953
VI.	Control of Consumer and Real Estate Credit	- Consumer credit control - Real estate credit control	- Repealed 1952 - Repealed 1953
VII.	General Provisions	- Small business encouragement - Authority to create new agencies, issue regulations, gather information - Small Defense Plants Administration - Voluntary agreements	- In effect - In effect - Replaced by SBA - In effect, but greatly restricted in 1972

Source: FEMA, Resource Management: An Historical Perspective (Washington, D.C.: GPO, December 31, 1984), p. 6/13.

hand. Following the Chinese incursion on December 16, 1950, Truman established a temporary agency to manage mobilization, the Office of Defense Mobilization (ODM), and appointed its director to the Cabinet and the National Security Council. The ODM was intended as a coordinating and policy-making organization overseeing the other executive mobilization agencies. Other temporary agencies were also established, usually within the existing Department-level offices, including the National Production Authority, the Defense Production Authority, and the Defense Manpower Administration. One notable exception was the independent Economic Stabilization Agency, establishment of which was required under Title IV of the DPA. A significant political factor in the planning for the Korean police action, one that would foreshadow the decision of President Johnson fifteen years later, was the decision to curtail civilian production as little as possible. In addition to having a strong industrial base, the mobilization plan emphasized the need for a healthy civilian economic sector.

Moreover, the mobilization plan for Korea was not intended solely to meet the demands of conducting a relatively small-scale war; it was intended to prepare the nation for a full-scale, global war with the Soviet Union and it allies. For example, plans outlined in a 1950 National Security Council study, NSC-68, presented to the President two months prior to the outbreak of the war, called for the production of a one-year war reserve in preparation for a confrontation with the Soviet Union.

Numerous government supports were arranged to aid in the expansion of industry. Key among these were Section 124A of the Revenue Act of 1950, which allowed the rapid amortization of mobilization-related facilities over a five-year period. This program was carried out in two stages. The first, from September 1950 to August 1951, saw 3,328 applications for accelerated amortization approved with a write-off value of $6.3 billion. The second phase, starting in 1952, established criteria based on 229 desired expansion goals in specified areas, with a resultant aggregate total of $23.1 billion in write-offs before the program expired at the end of 1959.[7]

Additional incentives and government supports established by Congress and the Administration during the Korean War included:

o *Guaranteeing markets and prices for certain goods.* If no buyer was found for goods ordered by the government to stimulate initial expansion of an industry, the Government Services Agency (GSA) would purchase them at a certain percentage of their value. This was used largely for machine tools and raw materials. At the start of the Korean War, GSA placed sixty-one contracts with machine tool makers for more than 50,000 tools valued at more than $800 million. The government lost less than 0.7 percent of the cost of these tools.[8]

o *Encouraging expansion via government direct and guaranteed commercial loan programs.* By the end of 1952, more than 225 direct loans had been made by the government valued at more than $300 million, with a further $2.1 billion in commercial loans underwritten.[9]

o *Covering the cost of new facilities and special tooling.* Costs for such specialty military equipment would be reimbursed by the government (an incentive still used today).

o *Providing government-owned facilities and equipment for the use of the manufacturer, usually on a lease basis.*

o *Government grants for research and development.* New manufacturing techniques and technology that would increase efficiency or reduce usage of critical materials would be subsidized by the United States.

Using the authority provided by the DPA, the Revenue Act of 1950, and other pieces of enabling legislation, the United States, following the outbreak of the Korean War, reconstituted the defense industrial base that had been allowed to deteriorate so quickly after World War II. By July 1952, U.S. aircraft production had grown to 800 aircraft per month, two-thirds of the planned peak production rate and more than three times that of 1950.[10] In January 1953, production of military aircraft approached 1,000 planes per month.[11] Most war industries were similarly expanding their capacity.

The gradual winding down of fighting in Korea---ended by a truce in 1953---slowed the pace of expansion and saw the cancellation of several provisions of the Defense Production Act, including the statutes on wage and price controls, the authority to requisition and condemn property, and control on real estate credit, all of which were repealed in 1953 (controls on consumer credit had been cancelled in 1952 to stimulate the civilian economy). Despite these reductions in executive authority, the planning for a future all-out war continued through the 1950s, with the establishment of programs and organizations to enhance the efficiency of future mobilizations and maintain a healthy defense industrial base.

Most significant of the new initiatives put into place in the period between 1954 and the

Vietnam buildup were the Preferential Planning List (PPL) and the Production Allocation Program. The PPL established a list of militarily critical end-items for which mobilization planning was to take first priority. This helped reduce the number of items for which detailed planning was required, a necessity given the limited resources devoted to mobilization planning. Under the Production Allocation Act, production sources of critical items were assigned prior to mobilization in order to prevent conflicts in procurement planning between the services. This allowed for the development of realistic production schedules prior to actual mobilization.

Other significant mobilization initiatives of the post-Korea Cold War period included the Industrial Defense Program, the Priorities and Allocations Program, and Industry Preparedness Measures. Service compliance with these programs and guidelines was less than complete, however, with the Air Force especially deficient in mobilization planning due to its view that any future war would involve an immediate strategic nuclear exchange and thus preclude the need for mobilization.

Vietnam: The Mobilization That Never Was

Direct U.S. involvement in the Vietnam conflict came about in such a manner that at no one point could it have been said, "We are now at war, and the time has come to mobilize our defense industry." But because of the lack of clear definition and the highly charged political question of U.S. involvement in the war, the decision was made, whether by design or default, not to mobilize the defense industrial base in support of the war effort. The result of this decision to fight the war at a level below the mobilization threshold had an impact on U.S. defense industry and mobilization capacity that is still felt today.

The decision to rely on "surging" key sectors of the defense industry and drawing down war reserves, rather than a more traditional approach of mobilization, flew in the face of all previous experience and the detailed mobilization planning accomplished during the 1940s and 1950s. A "surge" is defined as increasing production to its maximum limits without adding new capacity in the form of additional equipment and facilities, which would be "mobilization." However, the mobilization plans themselves had been allowed to become dated and had lost much of their usefulness in the context of the Vietnam conflict---even if they had been consulted. Also, because no national emergency was ever declared during the war, much of the legislation allowing the government to control defense production could not be used (although the emergency declared during the Korean War had never officially been rescinded).

Unlike previous war situations in the century, the United States created no new temporary agencies to administer wartime procurement and industrial planning for the Vietnam War. In part this was the result of the decision to conduct the war without mobilization, but another factor was the expanded size of the federal bureaucracy. Never before had the government had so many specialized administrative departments and agencies, many of which had grown out of wartime agencies, devoted solely to military procurement and planning. Had these departments not already existed, it would have been difficult for the government to conduct the war without creating mobilization agencies.

The decision to depend upon peacetime procurement practices and competition, largely ignoring the National Priorities and Defense Materials System (the "DO/DX System") then in existence, created long lead times on many systems and parts as they queued up behind civilian production orders. Planned producer lists were also not used since competitive bidding often meant that the low bidder was not the company previously designated for that product. This also led the services to compete among themselves for contracts with the same producer, further slowing the procedure and inflating costs.

As might be expected, the low-profile buildup did nothing to encourage historically hesitant private industry to expand its defense-related facilities. This forced the government to spend millions of dollars on incentives and in reactivating its reserve plants. Of the twenty-four ammunition plants being maintained in reserve status, all but two were brought back on-line during Vietnam.[12] Increased orders to private industry also absorbed much of the already scarce surplus capacity available, thus restraining long-term modernization of plant facilities. This lack of industry modernization was to haunt American industry for years to come and, when combined with reduced postwar defense budgets that failed to make beneficial reductions in war reserve stocks, left the American military unready to fight and unable to mobilize.

Post-Vietnam

Mobilization planning in the post-Vietnam era has been schizophrenic, driven by the controversy over whether the next war will be short or protracted, an argument with its roots in the Cold War concept that the next conflict would be a total nuclear war. The rationales behind the two arguments are as follows.

Short War: The United States and its allies are not prepared to sustain a conventional war much be-

yond thirty days (some estimates say only two weeks), at which point we will have to resort to the use of tactical nuclear weapons, which will inevitably escalate to the strategic level, resulting in a massive nuclear exchange destroying both sides. An oft cited corollary to this argument is that, in any case, we can not afford to fight a long conventional war; the effort of sustaining such a war would destroy the economies of the U.S. and its allies.

Long War: Based on 20th-century historical precedents, wars tend to last far longer than anticipated. The First World War was expected to last for a few months at most (the catch phrase was "Home Before the Leaves Fall") because neither side would be able to sustain the effort beyond that. The reality was that after both sides had run through their initial ammunition supplies the war stalemated and, as national industries geared up to mobilization levels, dragged on for another four years.

During most of the last three decades, the argument that any major war will be short has held sway and had a negative effect on mobilization planning. Only in recent years has the possibility of a protracted conventional war been given more than scant attention and has become explicit in operational planning in the Defense Department and strategic concepts prepared by the Reagan National Security Council.[13] In addition to these government planning inadequacies, U.S. industry has been hard hit by foreign competition, with many critical industries reduced to a fraction of their former size. When these two factors are considered together, a bleak picture for the U.S. defense industrial base is the inevitable result.

According to several well-placed observers, it would be difficult for the United States in the late 1980s to support a war on the same scale as Vietnam without a major mobilization effort. U.S. capability to surge even selected weapons, as would be necessary to support an ally engaged in a limited war, is suspect. When efforts were made at the time of the 1973 Yom Kippur War to surge tank production, for example, the effort ran into a wall. The facilities to surge production simply did not exist. Similar draw-downs of U.S. reserves to support allies, as with the sale of General Dynamics MK-15 Close-In Weapons System and Raytheon AIM-9L missile to Great Britain during the 1982 Falklands War, would not be sustainable over extended periods of time without seriously damaging the viability of U.S. war reserves. Without this ability to support friends and allies in times of need, the credibility of American foreign policy, often tarnished in recent years, might suffer blows from which it could take years to recover.

The "INCON" Concept

One of the more promising ideas for giving industry a better jump on preparing for a crisis is the "INCON" concept. It would establish a series of industrial conditions (INCONs) to operate in parallel with the defense condition (DEFCON) system that the armed forces use. When the military moves from DEFCON 4 to DEFCON 3, that triggers an alert to the forces to transition from a peacetime posture to the first level of preparation for war. Under the new concept, which a growing number of mobilization thinkers are enthusiastic about, the defense industry would move to INCON 3 when the military moves to DEFCON 3, and so on.

This would not help if war erupted without warning, of course, but most knowledgeable people regard the so-called "bolt out of the blue" scenario as remote anyway. Each change in the INCON would put a number of planned actions into effect, just as a DEFCON change does for the military. INCON 3, for example, might bring about differences in priorities, diversion of resources and assets, and waiver of some time-consuming regulations and requirements.

This would position industry to respond faster if a surge or mobilization is ultimately required. It would have two other benefits as well. A change in the INCON would be another way for the nation to show resolve during a crisis, thus reinforcing the probability that war will be deterred. It would also force the war planners and others working up lists of defense requirements to include the industrial base in their calculations, since DEFCONs and INCONs would be linked.

If such a system were instituted, the first exercise of it would probably be chaos, given the present situation. But even that could be useful. After all, it was the shock at the devastating outcome of exercise "Nifty Nugget" in 1978 that made the military get serious about its own ability to mobilize. More recently, an exercise called "Salty Demo" showed how vulnerable air bases are to attack and disruption in wartime and led to the new Air Base Operability program.

End Notes

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[11] U.S. Office of Defense Mobilization, *The Job Ahead for Defense Mobilization: Eighth Quarterly Report to the President* (Washington, D.C.: GPO, January 1, 1953), pp. 13-15.

[12] Vawter, *op.cit.*, p. 55.

[13] See, for example, *National Security Strategy of the United States* (Washington, D.C.: National Security Council, January 1987), pp. 27-31.

3. Why We're in Trouble

The nature of the world economy has changed dramatically since the end of World War II, when U.S. industry was the envy of the world. Strong foreign competitors have arisen and staked claims to large shares of the U.S. commercial market, virtually taking over some sectors, such as consumer electronics and mass-produced computer memory chips. Gradually this dominance of commercial markets began to carry over into growing sales of defense-related goods such as microprocessors, machine tools, and electronic parts.

With these penetrations has come a proportional decline in the number of U.S. firms in militarily critical manufacturing areas, a more troubling prospect for the future. Companies unable to compete with foreign products have closed their doors, putting Americans out of work and leading to a growing trend of dependence on foreign sources for many goods vital to the national defense.

Another area of growing concern has been the acquisition of U.S. defense-related companies by foreign corporations, leading to fears that these "former-U.S." companies might not be as responsive to U.S. national interests as domestically owned firms during an emergency. Further, complaints have been voiced that new, foreign owners may have purchased U.S. firms simply to strip their innovative ideas and skilled people for their own use and not to maintain the companies' viability in the marketplace. Still other observers have decried the movement of U.S. manufacturing operations "offshore," to developing nations where, according to popular wisdom, the "cost of doing business is lower."

On the opposite side of the coin, many respected business analysts see this "globalization" of the economy as a positive trend for the nation and the defense industry. For example, they are encouraged by cooperative ventures with foreign companies on new weapons and systems, citing the benefits of interoperability among U.S. and allied forces and the allegedly reduced procurement costs of such multinational systems.

CHART 7

DECLINE IN THE "LOWER TIERS"

PRODUCT/ITEM	NUMBER OF SUPPLIERS	PRODUCT/ITEM	NUMBER OF SUPPLIERS
Airborne radars	2	Titanium sheeting	3
Aircraft engines	2	Titanium wing skins	2
Aircraft landing gear	3	Titanium extrusions	1
Aircraft navigation systems	2	Special ball bearings	1
Infrared systems	2	Needle bearings	2
RPV/Missile/Drone engines	2	MILSPEC-qualified connectors	3
Gun mounts	2	Radomes	2
Doppler navigation systems	2	Image converter tubes	1
Aluminum tubing	2	Specialty lenses	2
		Optics coatings	1

Analysts differ in how they categorize firms in the supplier-subcontractor base, so their tallies differ, too. But all agree that the "lower tiers" have declined. This is the current breakout used by Air Force Systems Command.

Source: Charles Hooper, "Dirt to Deterrence:" Industrial Base Excellence (U.S. Air Force Systems Command, undated briefing).

While many U.S. defense products still sell well overseas, especially aircraft and high-technology electronics equipment, growing numbers of foreign countries are demanding that "offset" agreements be included in sales packages. Such offsets require the manufacturing firm either to manufacture part of the product in the purchasing country, as part of coproduction arrangements, or to buy other, unrelated goods from that country over a given period of time.

Until recently, one of the key reasons for U.S. preeminence in weapons development and manufacturing has been its lead in advanced research. However, within the past ten to twenty years this advantage has been steadily eroded as America's competitors have increased their own investments in research and development. At the same time, U.S. investment in defense-related research and development, in both the federal and private sectors, has declined substantially, leaving the United States in danger of dropping further behind the "state of the art" in weapons and defense-related systems.

How It Happened

For the past ten years at least, the defense community has been concerned about contractors and suppliers dropping out of the industrial base. This happened for a variety of reasons, and it did not occur overnight.

One snapshot of the problem was taken in 1982, when Air Force Systems Command tried to rally prime contractors for a joint effort to keep subcontractors and suppliers of aerospace specialty components in the fold.[1] At that time, AFSC reported that the number of such firms doing defense work had decreased by more than forty percent in the previous fifteen years.

Some of those firms had moved to the commercial market---then, as now, hungry for high-technology products---where the profits were better and the red tape was less. Others simply folded. About 400 foundries went out of business in the 1970s, mainly because of environmental, safety, and health requirements. AFSC also cited as a cause the national shortage of technical manpower, a problem that the Defense Department still identifies as a major deficiency of the industrial base.

The defense industrial base---like the defense acquisition process itself---suffers terribly because of the instability and uncertainty caused by ups and downs in the federal budget. Last winter, for example, the armed forces had to implement a $20.5 billion cut to the defense budget, decided upon nearly three months after the fiscal year had begun. In January 1988, the Blue Ribbon Commission on Long-Term Strategy observed that from one year to the next since 1950, the defense budget has often fluctuated up or down by ten percent and that there have been occasional changes of twenty to thirty percent. In those three decades, the roller coaster did not head in the same direction for more than six years at a stretch.[2]

This pattern hardly encourages long-range commitment and capital investment from the supporting industry. That along with concurrent inclinations by American industry in general to focus overly on quarterly profits is a major factor in lost competitiveness by U.S. defense contractors.

A number of people---including Gen. Robert T. Marsh, USAF (Ret.)---believe that stunted productivity may be the most fundamental problem of all with the defense industrial base. Defense contractors have not invested in capital improvements that would have made them more productive and efficient.

"The defense industry suffers from insufficient capital investment, resulting in excessive touch labor and hence less than desired quality and productivity," General Marsh said in testimony to the Senate recently. "This in turn leads to unduly high costs and reduced international competitiveness. These weaknesses exist throughout the prime and lower tiers of the industry. A perplexing characteristic of the defense industrial base is an overcapacity in a number of areas at the prime supplier level but a shortage of qualified suppliers for many critical materials and components in the lower tiers."

Failure of defense industry to modernize is a problem with multiple roots of its own. Economists have been lecturing for years about the proclivity of American business to emphasize short-term profits over long-range development. In the semiconductor industry, stock is traded at a breakneck pace, the volume of turnover being equal to a complete change in ownership every six to nine months. Management is under pressure from investors who want their earnings quickly.

Most studies of the defense industrial base over the years have found that the tangle of incentives and disincentives embodied in the vast number of laws, regulations, and requirements undercut the growth and health of the defense industry.

A February 1988 study published on behalf of the Aerospace Industries Association, the Electronic Industries Association, and the National Security Industrial Association examines the effect of policy changes between 1984 and 1987 on capital formation.[3]

"Business is fundamentally about risks and returns," the study said. "As essentially the only purchaser of highly specialized defense equipment, DoD controls both sides of the risk/return balance (at least for major systems procurement). In the

period we have just examined, DoD and Congress decided to adjust what was viewed as an imbalanced risk-return relationship. Unfortunately, it reduced rewards and increased risks simultaneously, with not one but multiple uncoordinated adjustments. At the same time, Congress significantly increased the industry's capital requirements (by reducing progress payments and deferred tax financing).

"While some in DoD now claim industry is much more like commercial industry, Wall Street is saying it will not provide it with capital at the same rate as commercial industry. Wall Street might provide the capital if it saw the opportunity for high returns (as it does for biotechnical companies, for example); the industry might live with low profits if the government provided more of the financing and did away with the cost-sharing, fixed-price development, and other unreasonable risks. But as matters now stand, the government has stepped out, Wall Street is unwilling to step in, and the industry is unable to."

It is not only the large prime contractors who feel the incentives and disincentives are structured the wrong way. Dennis M. Biety testified to the Senate Armed Services Committee in March on behalf of Pneumo Abex Corp., a first tier supplier of hydraulic subsystems. He said that his firm, which does about half of its business in military sales, is typical of the subcontractor base.

According to Mr. Biety, suppliers and subcontractors see DoD as chasing short-term savings with policies that are often counterproductive in the long run. He said that firms at his tier are finding it "increasingly inadvisable to invest in the development of advanced technology or manufacturing capability for defense systems."

Import Dependence

The United States is woefully dependent upon foreign sources for many components in its defense systems. The term "dependency," however, is often used imprecisely. In some instances, the mere fact that a part is purchased from abroad is termed a "dependency," when indeed an alternative U.S. supplier does exist but for varying reasons the government has not purchased from the American source. The Mobilization Concepts Development Center (MCDC) of the National Defense University has identified three elements of foreign sourcing.[4]

The first level of *foreign sourcing* is simply a "source of supply, manufacture, or technology" that is located outside the United States or Canada (Canada being defined by existing DoD acquisition regulations as part of the "industrial base" that is available to the U.S. during an emergency). *Foreign dependence* is defined by MCDC as a source "for which there is no immediately available alternative" in the United States or Canada. A *vulnerability* is a subset of foreign dependence encompassing only items "whose lack of reliability and substitutability jeopardizes national security by precluding the production, or significantly reducing the capability, of a critical weapon system."

These definitions permit a more accurate understanding of the United States' reliance on foreign manufacturers. While many component parts of U.S. weapon systems fall within the broadest category, *i.e.*, "source...outside of the United States or Canada," fewer are part of the second ("foreign dependence"), and even fewer are in the final group ("vulnerability"). These few, however, include parts from some of the most important weapons in the U.S. arsenal (see Chart 8 for a list of only *some* of these), and their unavailability at a

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CHART 8
NO CHOICE BUT FOREIGN CHIPS

GLOBAL POSITIONING SYSTEM
(satellites)

INTEGRATED UNDERWATER
SURVEILLANCE SYSTEM

DEFENSE SATELLITE
COMMUNICATION SYSTEM

FLEET SATELLITE
COMMUNICATIONS SYSTEM

SSQ AN-53B SONOBUOY

F-16 FIGHTING FALCON

AIM-7 SPARROW AIR-TO-AIR MISSILE

AM-6988 POET DECOY
(expendable jammer)

ARMY HELICOPTER IMPROVEMENT PROGRAM
(OH-58 Kiowa)

APG-63 AIRBORNE RADAR
(for the F-15 Eagle)

M1 ABRAMS TANK

F/A-18 HORNET

This is a *sampling* of U.S. military systems containing semiconductors that are available only from foreign sources.

Source: Defense Science Board, Report for the Defense Science Board Task Force on Semiconductor Dependency (Washington, D.C.: Office of the Under Secretary of Defense for Acquisition, February 1987), p. 64.

crucial phase during a surge or mobilization effort could severely hamper the war effort of the U.S. or its allies. A recent Joint Logistics Commanders study suggested that a total cutoff of foreign sources would almost immediately halt production of key weapons, such as the M1 Abrams tank, AIM-7 Sparrow air-to-air missile, sonobuoys, OH-58D Kiowa helicopter, and the F-16 Fighting Falcon and F/A-18 Hornet fighters for periods ranging from six to fourteen months after as few as two months of surged output.

The exact impact of foreign sources on a future U.S. industrial surge/mobilization is difficult to assess. One reason is simply the lack of detailed information on the sources of subcomponents used in many of the parts in our most advanced weapons. The July 1988 DoD report on industry competiveness equivocated on this issue: "The potential for divergent political or economic interests to disrupt the free flow on the most advanced technologies and products has never been addressed adequately in the few, limited American assessments of foreign dependencies."[6]

In fact, as the report acknowledges, the Defense Department does not know the extent to which foreign-sourced components are incorporated into the system it acquires. It has no reliable means of identifying such dependencies.

Critics have frequently faulted the government of not keeping track of where its subcontractors purchase their components. One frequently cited example is the purchase of industrial fasteners (screws and bolts) by contractors. In recent years, substandard fasteners purchased from foreign suppliers have been discovered in U.S. weapons. These fasteners, which do not meet military specifications, are deemed far more likely to fail during use than properly manufactured ones, thus endangering the lives of U.S. servicemen and the outcome of a battle.

Another even more difficult factor in determining dependency problems is that the odds that a given foreign source will be available in wartime would depend on the scenario of conflict. Listed below are some of the most probable types of scenarios that the United States might face that would require both increased industrial output and threaten the availability of foreign sources.

o *"World War III."* General war between the United States/Soviet Union. Threats to transportation lines would restrict access to foreign sources, but most countries in question would impose no restrictions on exporting goods to the U.S. (This is, in the minds of most professionals, the least likely scenario but the most commonly discussed and the basis for most of the wartime operational plans.)

o *Limited War.* The United States is engaged in a limited war similar to Korea or Vietnam in which one or more allies would also require weapons and logistical support. The location and nature of the war would determine availability of foreign sources. A politically controversial war might cause some countries to implement trade sanctions against the United States in protest of the conflict. This could have a definite impact on U.S. production capability, especially if key components were involved. The United States might be forced to make political concessions to the source nations or spend inordinate amounts of money establishing a domestic industry. (Given the political instability of the world today and the diverse regional interests of even the closest allies, this scenario is easily within the realm of probability.)

o *Ally Support.* A country allied with the United States is involved in a small war, and the United States is supporting its ally with arms and logistical help, as it has in the past for Israel and Great Britain. If the war is controversial, some foreign nations could refuse to permit the United States to purchase military-related goods or raw materials. (Based on past U.S. experience, the Arab oil embargo being one key example, the probability of such a scenario arising is quite high.)

Analysts argue, on the one hand, that "foreign sourcing" is either one of the gravest threats facing the U.S. defense industry today or, alternatively, that it is an unavoidable and healthy outgrowth of the ongoing globalization of the economy. In either case, the United States must make plans to deal with the possibility of losing foreign sources at a critical point. It is hard to argue that the United States not do something to protect itself from being hamstrung at a crucial moment, but the question is how far should, or can, the U.S. government go to protect itself? Some advocates recommend protectionist legislation requiring the government to "Buy American" on all defense procurement, which would mean allocating funds to reconstitute now-defunct industries in the United States to comply with such provisions. Others prefer less drastic measures, such as stockpiling critical goods and materials to tide industry over in an emergency, until production could be reestablished in the United States. The sticky issue in each of these options, however, is the availability of funding.

The present state of affairs is poorly understood even by the experts. General Marsh, referring to the many "hearings, speeches, books, and articles" on the topic, in early 1988 stated: "As I reflect back...I'm struck by the general nature of the statements of the problems and the lack of specificity of

recommended solutions, and that should not surprise anyone. Separating problems from their symptoms and identifying their causes in such a diverse industry comprising over a hundred thousand commercial enterprises is a mind-boggling challenge."[6]

During his March 1988 testimony before the Subcommittee on Defense Industry and Technology of the Senate Armed Services Committee, General Marsh identified a problem common to all previous industrial base studies: "The lack of an integrated assessment of the capability of the industrial base as a whole...[which] is absolutely essential before a realistic plan for revitalization can be formulated." In General Marsh's opinion, "without it, a remedial plan is meaningless."

Foreign Penetration and Offsets

The U.S. Senate in 1987 had already acknowledged the problem facing the U.S. industrial base: "The Defense Industrial base, for a variety of reasons, is losing its ability to respond to challenges from foreign industry and is rapidly losing its ability to respond to defense needs. To a growing extent, our defense needs are being filled by offshore sources. This is especially true for second and third tier industries. The ability of U.S. industry to support defense needs as well as compete in the world economy is one of the most crucial questions before the country."[7]

Beginning in the early 1970s, foreign business concerns began to compete aggressively for a place in the U.S. defense market. Although these firms initially made only small headway in selling large systems---vehicles and aircraft, for example---they quickly cut a niche for themselves in the area of specialty components, such as electronics and precision optics. American industry, meanwhile, was falling behind its foreign competitors in productivity and efficiency. Foreign manufacturers, able to offer products of comparable quality at prices below those of domestic firms, were aided in their marketing efforts by the U.S. government's push for lower costs in defense procurement. American prime contractors in some instances were forced to use cheaper foreign goods in order to remain competitive with their rivals, both foreign and domestic. Responding to pressure from the prime contractors to cut costs, subcontractors were also forced to purchase lower-cost foreign parts for their components.

The availability of cheaper foreign goods proved to be too much for many, already struggling U.S. defense-related firms, especially smaller manufacturers that could not afford to modernize their plants to compete with foreign industry. Several firms, which had managed to stay in business through these tough times, survived only to be bought out by their foreign competitors which saw the advantage of having U.S. subsidiaries. Still others, in an effort to cut their production costs, moved their manufacturing facilities offshore to foreign countries where their overhead and labor costs were substantially lower than in the United States. This movement cost America thousands of jobs and millions, possibly billions, of dollars in lost wages and taxes. It also left the country with a depleted subcontractor base that may not be able to support the nation's needs in an emergency.

During the research for this assessment of the U.S. industrial base, no hard information directly linking foreign competition to the decline in the U.S. defense contractor base was uncovered. Nevertheless, the "feeling" remains that lower-cost foreign goods and services were the cause for these "symptoms" recognized widely. Perhaps the words of Ring Lardner, noted American journalist and author, serve best in this situation: "The race is not always to the swift or the battle to the strong, but that's the way to bet."

Another pressure on U.S. subcontractors came from increasing demands for "offset agreements" by foreign governments that wished to purchase U.S. weapons. Offsets also serve as "wedges" making foreign penetration of U.S. markets easier. One official at the Swiss Embassy was quoted as saying, "We use offset agreements as door openers to tear down 'Buy American' restrictions."[8]

Offsets are defined by the Office of Management and Budget as: "A range of industrial and commercial compensation practices required as a condition of purchase of military related exports, *i.e.*, either Foreign Military Sales (FMS) or commercial sales of defense articles and defense services, as defined by the Arms Export Control Act and the International Traffic in Arms Regulations (ITAR)."

More plainly perhaps, but less official, offset agreements require the selling party to buy goods and services from businesses and industries within the purchasing country equal to a certain percentage of the contract's value. Offsets may also call for production under license of the product in the purchasing country or some form of coproduction. Products purchased under offset agreements can range from components specific to the product (direct offsets) or totally unrelated to the defense equipment transaction such as agricultural goods or tourism promotion (indirect offsets).

The potential effects of offsets on the U.S. defense industry and national economy are obvious: for every component part purchased overseas there is one less sale for any possible U.S. manufacturers, resulting in a substantial flow of dollars out of the country, further increasing the trade deficit and

introducing more foreign dependency into U.S. mobilization plans. Subcontracting firms bear the brunt of such agreements. A draft of a recent State Department report stated that in Fiscal Year 1986, twenty-one percent of all U.S. offset agreements impacted subcontractor-produced components, while the overall value of offset agreements negotiated by U.S. firms, as of January 9, 1987, was reported at greater than $12 billion for the period between 1980--84.[9]

In some cases, the value of offset agreements has been greater than the value of the initial purchase. A case in point was the December 1986 purchase of the Boeing E-3A Airborne Warning and Control System (AWACS) by Great Britain. After spending more than $1 billion on its own version of the AWACS, the Nimrod AEW 3, Britain cancelled the project and instead purchased the Boeing system. However, Britain demanded and received an offset of 130 percent of the purchase price; that is Boeing and its major U.S. subcontractors agreed to purchase British goods and services worth 130 percent of the aircraft purchase price. While Boeing will still make a profit on the sale (with a potential for even greater profits selling related training and maintenance), the subcontractor base suffers. British companies like Plessey, Racal Systems, and Ferranti will receive contracts for AWACS components. Boeing's major subcontractors, including IBM, Westinghouse, and Northrop, will also share the offset burden, each taking a percentage equal to its input into the aircraft.

Hazeltine, a producer of electronic components, originally held a contract with Boeing to provide displays and controls for the aircraft purchased by the U S. Air Force but had to give it up to Siemens AG of West Germany as part of an offset deal on the earlier NATO AWACS purchase. Nevertheless, Hazeltine then subcontracted the NATO AWACS work from Siemens. But in the British purchase, Racal---not Hazeltine---was selected by Siemens for the subcontract work since, as a British company, it counted toward the total offset. Although Hazeltine was still price-competitive, it could not provide an offset credit and, thus, lost the subcontract for the RAF AWACS.

Chart 9 shows the specifics of the Royal Air Force purchase and a similar one by the French government. Only ten percent of the offset purchases will be directly related to AWACS, the rest being purchases in the "high-technology defense and aerospace product areas," providing further opportunities for foreign penetration of the U.S. market. Other U.S. projects already under consideration for offset participation by British firms as part of the AWACS offset deal include:[10] *Boeing/Plessey Projects*: Avionics for Boeing's BRAVE 3000 remotely piloted vehicle; dipping sonar for the V-22 Osprey. *Westinghouse/Plessey Projects*: Gallium Arsenide technology research; SDI research program.

On the positive side, the British and French purchases will guarantee steady employment for 2,000 Boeing employees and another 700 at Westing-

CHART 9

THE AWACS OFFSET
(dollars in millions)

	VALUE OF SALE			VALUE OF OFFSETS		
	Firm	Option	Total	Firm	Option	Total
United Kingdom	1,172	144*	1,316	1,524	187	1,711
France	600	260**	860	780	338	1,118
Total	**1,772**	**404**	**2,176**	**2,304**	**525**	**2,829**

* To be executed by October 1988
** To be executed by August 1988

Source: Office of Management and Budget, Third Annual Report on the Impact of Offsets in Defense-Related Exports (Washington, D.C.: GPO, December 1987), p. 6.

house, producer of the aircraft's radar system. The sale also increases the likelihood that other countries may buy the aircraft, thus extending AWACS production even further. In addition, the operation of AWACS by the British adds significantly to NATO's defense posture.

A troubling new aspect of foreign sales are the frequent requirements for technology transfers along with the purchase. These provisions mean that the manufacturer must give the buyer some or all of the technological processes involved in the manufacture of the product. In the past, the United States did this in order to help its allies' military industries develop more quickly, thus contributing more to the common defense. In recent years, however, as foreign industries became more able to compete on an equal footing with U.S. firms, questions have been raised about the wisdom of giving the nation's best technology to its commercial rivals and, also, risking its loss to the Soviet Union. The 1986 Toshiba and Kongsberg Vabenfabrik cases, in which milling machines and computer-controlled systems containing technologies originally developed in the United States and considered militarily sensitive by the U.S. government were surreptitiously sold to the Soviet Union, are perhaps the most prominent instances of this.

CHART 10

OFFSETS: THE TOP SIX

Country	Sales	Offsets	Offsets %
Canada	2,632	2,810	106.7
Spain	2,906	2,404	82.7
UK	1,437	1,748	121.6
Israel	4,163	1,477	35.4
Australia	3,366	1,156	34.3
Turkey	1,893	1,071	56.6

This chart shows the top six foreign nations that have sales from the U.S. with offset obligations greater than $2 million. These figures cover the period from 1980--84 and are given in millions of U.S. dollars. The figures for the United Kingdom include the 1986 E-3A AWACS sale to that nation.

Source: Office of Management and Budget

More recently, the case of the Japanese FS-X next-generation close-support aircraft has created concern that the United States is giving away its technology too cheaply. Japan had requested a complete hand-over of the technology for manufacturing the F-16C Fighting Falcon aircraft under a simple license fee. Japanese firms would then further modify the aircraft, to meet their special requirements, and manufacture it entirely in Japan, with no provisions for U.S. inclusion in any new technological advances.

Publicity concerning the potential negative affects of the transfer prompted the Senate Armed Services Committee to warn in May 1988 that it would prohibit the transfer of U.S. technology in offset deals "if the agreements would significantly affect the U.S. industrial base and would result in a substantial financial loss to U.S. firms." The Senate defense committee said that U.S. firms must receive a "meaningful work-share" of the airframe contracts, and stated that the Memorandum of Understanding (MoU) governing the transfer should require that Japan "flows back expeditiously and without charge any technical improvements substantially derived from technology provided by the United States." Both countries signed the MoU in June 1988, with the work-share being distributed between Japan and the U.S. on a 2:1 basis. Japanese firms will be responsible for the aircraft's radar and electronics, while U.S. firms will supply the engines and other hardware.

In addition to its warning on the FS-X, Congress has considered requiring the Department of Defense to begin negotiations with foreign countries to put an end to offsets, even though many experts believe that, however bad offset agreements may be, they are a genie that will be impossible to get back into the bottle.

Nevertheless, a lawsuit filed on April 8, 1988, by a private group, the National Council for Industrial Defense (NCID), would require DoD to adhere to "Buy American" provisions currently in effect, which they claim have been circumvented through blanket waivers granted in Memorandums of Understanding with U.S. allies and trading partners.

William G. Phillips is the president of the NCID. Mr. Phillips's group, which claims to represent more than 5.2 million members (which it declines to identify) associated with the defense industry, is concerned about the damage caused to the defense industrial base by offset agreements and the "illegal" use of offset agreements for political purposes such as cementing base agreements and smoothing over policy squabbles with NATO allies.[11]

Other observers have recommended that the United States counter the "pro-foreign trend" by requiring offsets from foreign companies selling to DoD. They contend that, at the least, this could be used as a bargaining chip in negotiations with foreign nations to restrict or eliminate future offset

requirements. The utility of such a position, however, is limited by the still low level of major purchases of foreign military goods by the U.S. government.

Options

None of the alternatives available to deal with foreign dependence and penetration of the U.S. market are ideal. The three most commonly suggested---strict "Buy American" requirements, creation of a finished or semi-finished goods stockpile to be used until U.S. industry is able to produce the item in question, and the laissez-faire approach of letting things stand as they are---all have substantial drawbacks.

Putting a stringent "Buy American" requirement in place is considered, relatively speaking, the most expensive, due to increased procurement costs created by the need to support an industry whose only or principal customer is the Department of Defense. Such an act would also anger foreign governments and free-trade advocates in the United States. The highly touted joint ventures between the United States and its allies would have to be eliminated or sharply curtailed, and the long-sought "international two-way street" would be closed.

Stockpiling of finished or semi-finished goods would also be expensive. The current National Defense Stockpile, considered inadequate for and nonrepresentative of modern needs, is more than $10 billion short of materials needed to support the nation in the event of a national emergency. It seems unlikely that Congress would authorize additional expenditures for a "parts" stockpile large enough to support surge requirements until U.S. sources could be brought online.

Even if only key components were purchased for the most important programs---and designating the "most important" would be a huge task in itself---the cost would be high. One promising step in this direction, however, is the "rolling inventory" concept, in which components needed for future production are ordered early in the acquisition process to prevent interruptions in production schedules. These parts would also be available for production surges and at the end of the production run the rolling inventory is simply used up. One problem with this system is the uncertainty in the size of rolling inventories needed because of changing procurement plans brought about by the pendulum-like political and budgetary swings in Washington's defense policies and programs. As a result, rolling inventories have been set up for only a very few programs with a known, long-term future procurement horizon, most notably the TOW anti-tank guided missile.

Maintaining the status quo, while seemingly the easiest option, would satisfy the least number of people. One group, comprising "free-traders and internationalists" (perhaps the most articulate member of the Reagan Administration in support of this policy position has been Deputy Under Secretary of Defense for Planning and Resources Dennis Kloske), seems intent on increasing the global nature of U.S. defense procurement and further encouraging cooperative programs among the United States, its friends and allies, citing the advantages of reduced costs and increased interoperability. The other faction, comprising principally U.S. businesses---both large and small---and nationalistic strategists, are likely to favor some form of increased self-sufficiency, though probably stopping short of an autarkic "Buy American" requirement. Neither side is content with things as they currently stand and will strive to shift things in their policy directions, making maintenance of the status quo, good or bad as it may be, less certain.

Defense Research

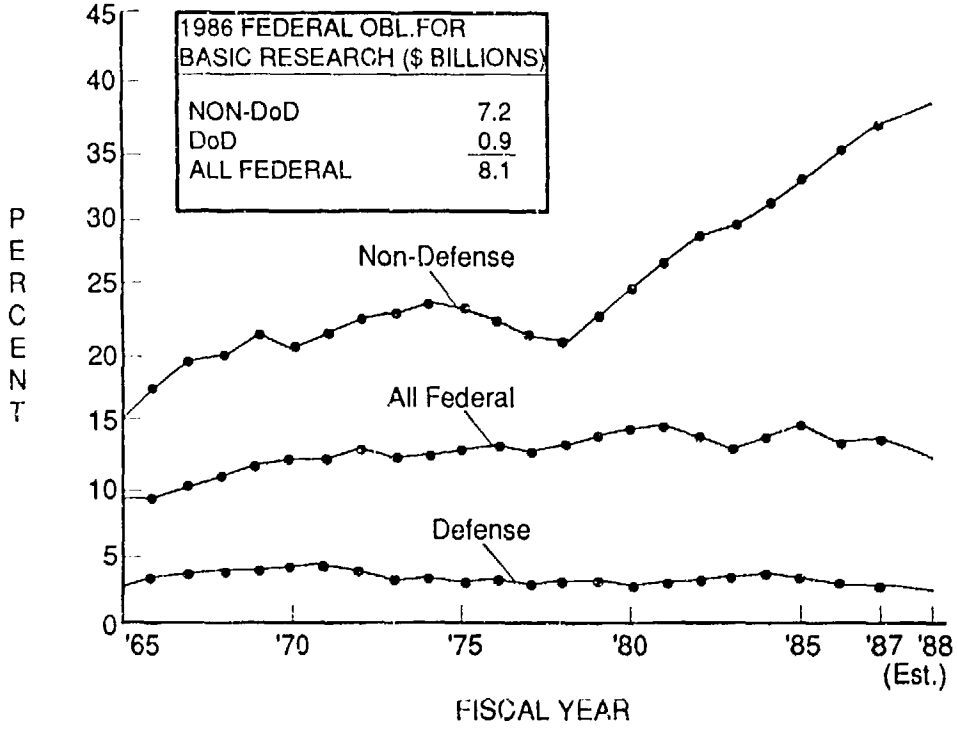
The United States and its allies have come to depend upon advanced technologies to counter Soviet/East Bloc superiorities in manpower and numbers of fielded weapons. In the view of many experts, however, the United States has nonetheless relinquished its traditional leadership in the high-technology fields to foreign competitors, who have invested more heavily in basic research and development efforts and who can translate their technological advances into finished products more rapidly than is the case in America.

Two reasons are frequently cited as the principal causes of America's faltering leadership in the R&D arena. First is the failure of the federal government to invest in innovative research programs and in its restrictive policies on funding private Independent Research and Development (IR&D) projects. The second, not restricted solely to the defense sector of American industry, is an overriding interest in short-term profits rather than in building healthy, long-term programs of corporate growth and development. In contrast, foreign competitors, most notably the Japanese, seem willing to sacrifice immediate profits for greater future market shares and move aggressively to retain their shares during economic slowdowns.

Chart 11 is a graphic representation of federal basic research funding broken down into defense, nondefense, and aggregate spending. As is evident, the DoD share of the total federal R&D investment has been slowly decreasing since 1965 and failed to rally even during the Reagan military buildup in the 1980s. This downturn occurred at the same time that the U.S. and its allies were depend-

CHART 11

THE SLUGGISH PACE OF DEFENSE RESEARCH



Federal basic research as a proportion of total federal R&D.

Source: U.S. Congress, Senate, Committee on Armed Services, Hearings on S. 1174, 100th Cong., 1st Sess., pt. 7, 1987, p. 3257.

ing more and more on their technological advantage to counter dramatic Soviet numerical advantages. Funding for university research, traditionally one of the most important elements of a strong, national R&D program, fell from approximately fifteen percent of total federal R&D expenditures to less than twelve percent between Fiscal Years 1983 and 1988, after rising steadily since 1960. Nevertheless, total federal government outlays for all R&D rose forty percent between 1983 and 1988.

The blame for this rests equally with Congress, the Department of Defense, and the White House. Research has long been considered the most painless area in which to cut military spending. DoD often failed to request money for adequate research or efficiently use what was provided, preferring to spend what it could get on procurement, while Congress frequently failed to act when funds were needed, also favoring procurement, especially that likely to bring federal funds to constituents back home. And, when either or both looked to the White House for leadership on ways to maintain the important contribution of R&D to the future well-being of U.S. national security, the Executive Branch consistently failed to provide it.

In an effort to make up for this lack of federal funding, the Defense establishment has encouraged private industry to take on more of the burden. Conversely, according to industry partisans, the government also began to make IR&D efforts less attractive to industry by requiring private firms to pay more of the costs out of pocket and reducing the number of such costs deemed reimbursable. The Reagan years also saw the use by acquisition officials of fixed-price contracts for many R&D projects, further cooling industry's ardor.

Sluggishness and indecision in both of these crucial arenas has resulted in the United States losing ground to or even trailing behind many of its global rivals in certain technical fields, creating the possibility that future U.S. weapons and systems will be built using something less than the most advanced technology available. It is even possible that the best technology will not even be available,

because it will not be American.

Federally Funded Defense Research

Government-supported research comes in two varieties: in-house, conducted at government-owned and operated laboratories, and federally funded programs, as part of a grant or contract, at non-government institutions such as universities, private laboratories, and Government-Owned, Contractor Operated (GOCO) facilities. Federally owned facilities include such well-known laboratories as Lawrence Livermore, Sandia, and Los Alamos. Each of the military services also has its own dedicated research facilities to meet its specific needs. Examples include the Naval Weapons Center at China Lake, California, and the aerospace research facilities at Wright-Patterson Air Force Base, Ohio. The Defense Advanced Research Projects Agency (DARPA), perhaps the best known defense research organization, relies on both its own personnel and on cooperative programs with civilian institutions.

America's defense labs have given the nation a wealth of innovative and effective weapons and military systems throughout their history, employing some of the most skillful and experienced scientists and researchers in the world. Unfortunately, declining budgets and expanding opportunities in the civilian sector are making it harder for the government to attract the best people.

Part of the cause of this "brain drain" from government labs is the higher salaries available in the private sector. A government laboratory director is limited by civil service rules to a salary of approximately $72,000, while his private sector counterpart may be making as much as---if not more than---twice that amount. The salary discrepancies between new hires is similarly discouraging. A recent government survey found that newly hired scientist and engineers in the private sector could expect to make $10,000 more than those who chose a government career, with this gap in pay increasing over time.[12]

Another reason for the difficulties being encountered at federal facilities is related to management and leadership. The number of innovative projects under development at government facilities is steadily shrinking as the decision is made to concentrate on more conservative projects where the risk of failure is lower. As one government report expressed it, "More attention is given to avoiding mistakes than producing results."[13] Certainly this is because of the spiraling cost of high-technology research and only partially to a failure of leadership. Nevertheless, the practical effect is to make private sector work look even more attractive.

The 1987 Defense Science Board (DSB) summer study on Technology Base Management pinpointed the factors that are important in attracting and keeping highly qualified scientists and engineers: High-quality colleagues; the opportunity to work on exciting, significant projects; an environment conducive to high-quality technical work, including management, equipment, technical support, procurement support; and adequate salaries and opportunities for advancement, including continuing education.

While the United States retains an admirable national laboratory system, containing what the DSB report termed "pockets of technical excellence," the future is far from bright. The government needs to develop ways of attracting the nation's "best and brightest" minds in order to return the laboratories to their former status. Several proposals have been made, most of them centered around modifying federal personnel regulations to make it easier for the government to reward excellence and offer more incentives to professionals.

One of the most promising proposals has been tested at the Naval Weapons Center at China Lake as a "Demonstration Program" authorized under the Civil Service Reform Act of 1978. The program has six main elements outlined below:[14]

- A simplified classification system that allows optimal development and use of scientists and engineers and that maximizes the personnel system process.

- A simplified and improved performance evaluation system.

- A performance-based pay system, allowing laboratory management to reward excellent performance.

- Provision for starting salaries for new professional scientists and engineers that are competitive with those of the private sector.

- Performance-based retention in time of a reduction in force.

- Rewards for bench-type scientists and engineers (nonmanagement) for technical contribution rather than management.

The need for renewed innovation and creativity is more difficult to satisfy. The Defense Science Board, in its 1987 report, said that "there is a growing concern that weak R&D leadership and bureaucratic forces are creating an environment which progressively discourages appropriate technical risk taking within DoD."[15]

While modifications of pay and promotion

regulations may make federal labs more competitive, they will do little to change the nature of the work. So long as federal R&D budgets remain tight, many managers will be unwilling to invest their scarce resources on high-risk/high-payoff projects and will continue to "play it safe" by following a program of conservative research and development. Willingness to invest in innovative research is largely a function of the manager's willingness to risk failure. Most observers agree that if these difficulties are to be surmounted the government must encourage its directors and supervisors to take risks and not worry about a single failure damaging their careers.

Federally Funded Research

Federally funded research and development suffers less from a lack of qualified people than the federal programs, but it still is generally constrained by a conservative mentality that is fostered by government agencies and "corporate" management. As the President's Commission on Integrated Long-Term Strategy recognized, "...the substantial R&D undertaken by U.S. defense industry (reimbursed in part by the Department of Defense) has changed significantly in its character. While this effort was highly innovative in the 1950s and 1960s, it has become increasingly conservative in the 1970s and 1980s. Today, it has become far more an effort to reduce technical risk than to innovate. In some measure the Pentagon is responsible for the new emphasis. The main criterion for reimbursement used to be the innovation levels of the work; today the controlling question is apt to be whether industry's R&D is sufficiently related to an ongoing weapons program."[16]

The solution in both cases, federal and private, is the same: greater freedom for competent managers to use their own judgment and initiative, but the pressure to not fail is, perhaps, even greater in the private sector. Failure means a loss of immediate profit, which, as mentioned before, has become more important than the promise of future returns.

In the past, one of the most important components of American research was the nation's universities. The great academic minds of modern times led teams of scholars and scientists to amazing discoveries in science and technology. Nurtured by public grants these academicians and institutions provided many of the major breakthroughs that led to U.S. technological dominance in the postwar era. In recent years, however, government funding for university research has fallen significantly.

In an effort to correct this trend, a University Research Initiative (URI) was established by Congress in Fiscal Year 1986. The URI focus is on multidisciplinary research projects unlikely to be undertaken without government funding. Congressional enthusiasm apparently peaked in the program's first year. Funding was set at $169 million in Fiscal Year 1986 but had dropped to $85 million in fiscal 1988 and is expected to be no higher than $95 million in fiscal 1989. Long-term support of the program, which will determine its ultimate value, remains uncertain because of shifting priorities in an era of constrained budgets.

If the United States is to retain or regain its technological edge, it must embark upon a new age of discovery by making substantial and long-term investments in basic research, investments only possible through the vast resources of the federal government. Without the foundation provided by this work, the nation may find itself technologically barren and reduced to spectator status in the world of tomorrow.

Independent Research and Development

The second facet of the U.S. research base is IR&D. IR&D is company-initiated, company-funded research that is separate from work performed under contract to the government. In defense-related IR&D, the company determines the direction its research must take for it to remain competitive, although the basic program is approved by DoD in advance. After completion of the project, the company is reimbursed for part of its expenses.

Typically, the government reimburses the contractor no more than forty percent of the costs of defense-related research but obtains access to and use of all IR&D performed. Both sides claim that payments are inequitable, with industry representatives remarking that they are too low, while the government argues that they are too high. In an effort to adjust the balance to a more favorable level and reduce defense budgets, DoD has recently considered several possible modifications to the present IR&D system. A 1988 Defense Resources Board (DRB) issue paper offered a number of ways to modify reimbursements. Chief among these options was eliminating all or most reimbursement payments, which was not well received by industry. A less drastic measure suggested IR&D payments be turned into grants, a move that, if carried out, would permit DoD to specify the direction of research; many observers fear that this would seriously affect industry's ability to carry out timely and innovative work.

On a more positive note for defense contractors, the same report also presented the option of leaving payments at their current level or even increasing reimbursements by an unspecified percentage. The latter course would obviously please industry, which cites a 2:1 exchange ratio of value

received for dollars spent on IR&D, based on a 1986 RAND Corporation study prepared for the House Appropriations Committee. Another option listed in the DRB paper would request the removal of a congressionally mandated cap on annual IR&D costs, permitting an enlargement of the current program. Under Secretary of Defense (Acquisition) Robert Costello in 1988 supported such a move and has also proposed the establishment of a DoD/industry committee to review the IR&D process. As of mid-July 1988, however, the DRB appeared to be leaning toward a cut in IR&D reimbursements to contractors of about $1.2 billion, almost half of the $3 billion previously envisioned for IR&D payments.

In response to industry charges that the use of fixed-price R&D contracts was unfair, the Senate included language in its Fiscal Year 1989 budget authorization that restricted the use of such contracts on high-risk projects like the Advanced Tactical Fighter (ATF) and Advanced Tactical Aircraft (ATA). The Senate bill noted that "in such cases the contractor bears an inordinate amount of risk, which creates the potential for the contractor either sustaining losses through unanticipated costs or the government having to renegotiate the contract." The Senate also would require an "equitable and sensible allocation of program risk," and that all fixed-price R&D contracts over $10 million be reviewed by the Under Secretary of Defense for Acquisition (an action already set in place by a February 11, 1988, memo by Under Secretary of Defense for Acquisition Robert Costello).

Although the precise nature of the IR&D relationship between the government and industry is problematic, the importance of IR&D is not. Investments by industry have contributed to significant advances in military and manufacturing technology that otherwise might not have come about. How or if industry should be reimbursed must be resolved quickly and equitably in order to prevent a further widening of the rift that has developed between the two parties.

Government - Industry Relations

Relations between industry and the government are in a poor state, with each side accusing the other of bad-faith dealing. In general terms, the defense industry is unhappy with the level of work-in-progress payments the government is making and governmental unwillingness to reimburse industry adequately for expenses encountered in taking a more active role in developing next-generation weapon systems. The result, industry partisans claim, is that selling to the Department of Defense is no longer profitable. For its part, the government is accusing industry of overcharging for its products, billing the government for costs unrelated to manufacturing, such as donations to political campaigns, and numerous other illegal and unethical activities.

The most recent official assessment of these "adversarial relations" between industry and government concluded that they are "...major causes of declining American industrial competitiveness. The relationship between government and industry is characterized by government constraints on industry behavior intended to protect the public good against profiteering and shoddy performance and by industry performance *by the numbers* to stay within government constraints and to document compliance. The relationship between management and labor also is adversarial."[17]

In the 1988 MAC Group Study of defense contractor profitability, DoD policy toward the industry was characterized as being based on: "...a countercyclical relationship between defense expenditures and attitudes toward the industrial base. When expenditures are low, there tends to be concern that the defense industry will underinvest, dwindle, or otherwise lack the capability to meet defense demands. When expenditures are high, these concerns change to ones of excessive profitability and/or efficiency and low productivity driving up costs."[18]

The MAC report outlined the major points of contention between the defense industry generally and DoD:[19]

- Contract provisions requiring companies to share in the cost (and risk) of weapons development and the use of fixed price-type contracts in research and development.

- Reductions in profits allowed by the government on negotiated contracts.

- Reduced interest-free loans from the government (progress payments) for work in process and delayed payment of contractor bills.

- Requirements to capitalize and amortize investments in special tooling without government reimbursement.

- Reductions in other heretofore reimbursable expenses.

- Restrictions on the use of the completed contract taxation deferral method.

Profitability Issues

Government requirements for cost-sharing by contractors were instituted initially to help keep down the cost of developing new-generation

weapons. Many companies complain that this substantially increases their financial risk but fails to guarantee them an acceptable return on their investment. They argue that the subsequent production contracts may be granted to another manufacturer as part of the competitive bidding process or the program may be cancelled outright, in either case leaving them "holding the R&D bag."

The Air Force's Advanced Tactical Fighter is one of the first programs to make use of increased contractor participation in the R&D stage and, because of the level of risk involved, pushed major aerospace contractors into forming teams to share costs. Some analysts speculated that the team that eventually failed to win the procurement competition could stand to lose hundreds of millions of dollars in unreimbursed costs.

Another concern of industry's, already discussed in this report, is the use of fixed-price contracts for R&D work. In addition to administrative changes within DoD to restrict the use of fixed-price development contracts, the Senate included language in its Fiscal Year 1989 Defense Authorization Bill to limit situations in which such contracts could be used.

Initiatives to put ceilings on profits have proved contagious in recent years. Under rules laid down in Permanent Law 99-591, the amount of profit markup permitted on government contracts with a negotiated profit percentage was reduced by one percent. The MAC Group report said that, based on its analysis, this reduction could cost companies as much as ten percent of their profits on some contracts. DoD responded with an analysis of the MAC study that asserted that the reduction was "to correct the old profit policy which gave contractors one percent too much..." profit and pointed out that, in case, the reduction did not apply to competitive contracts.[20]

Reduced progress payments and other measures have also been relied upon to "rationalize" the procurement process. To help industry maintain adequate cash flows during the several years that it might take for a program to begin deliveries, the government has traditionally given industry essentially interest-free loans in the form of progress payments. This allows industry to avoid borrowing money from banks and paying interest, which is not a reimbursable cost on government contracts.

In 1986, Congress cut these progress payments from eighty percent to seventy-five percent in order to meet the Gramm-Rudman-Hollings deficit reduction targets. This reduction was maintained until May 1988, when Under Secretary of Defense (Acquisition) Costello raised the figure back to eighty percent. For small businesses the initial reduction was from eighty-five percent to eighty percent, which was later restored to eighty-five percent of costs. The government's analysis of the MAC Study also pointed out that lower interest rates had reduced some of the burden on industry of this new policy.

Another industry complaint concerned the decision by DoD to suspend its expedited payment of contractor bills and establish a thirty-day waiting period for payment on delivery invoices. Previously, the invoices had been paid within five to ten days of receipt. This effectively reduced the operating funds available to industry, forcing industry to turn to private sources for short-term loans in order to meet expenses, thus raising overhead costs and reducing eventual profits.

New governmental policy on reimbursements for special tooling requirements on certain contracts has also been criticized by industry. As part of its efforts to get industry to share in the cost of weapons development and manufacturing, DoD raised the requirement for contractor participation in special tooling and test equipment expenses to as much as fifty percent of total costs. This means that industry would be directly reimbursed for only a maximum of no more than fifty percent of its costs and would be forced to amortize the remainder over the life of the contract, or, in some cases, future contracts. When coupled with the elimination of investment tax credits in 1986, industry representatives claimed that the investment would take far too long to amortize fully, thus reducing profitability.

The government countered that there is always some degree of contractor investment and that very few contracts require fifty percent investment in special tooling. Recent changes in reimbursement procedures that allow 100 percent reimbursement in certain instances were also cited by the government as evidence that the situation was not as dire as industry spokesmen had claimed.

New regulations have also reduced reimbursements of other costs previously reimbursable either wholly or in part. Other areas of reduced reimbursements cited by industry included the government's refusal to pay per diem and travel expenses in excess of government schedules and congressionally mandated caps on IR&D and Bid and Proposal expenses. In response, DoD stated that the reductions were the result of closing loopholes in regulations and should have been controlled by contractors in the first place.

On top of these initiatives, recent changes in tax laws have had the effect of reducing tax deferments and increasing costs or lowering profits. Previously, tax on the profits of major defense contracts were deferred until the end of the contract, when the actual amount of profit could be

known with certainty. Changes made to tax law as part of the Tax Reform Act of 1986 and the 1987 Omnibus Budget Reconciliation Act eliminated about ninety percent of these deferrals. Contractors complained that they were paying too much money before their contracts actually began to show profits, forcing them to borrow more. DoD dismissed this claim by saying that progressive tax payments were only to ensure that the company paid its proper share of taxes and that much of the cost was offset by the reduced corporate tax rate.

One other area of concern to industry not covered in the MAC Study is the overregulation of the defense industry by both DoD and Congress. Several Executive Branch agencies, in addition to Congress and the Department of Defense, oversee the defense procurement process, and each conducts periodic audits and inspections. Industry, while acknowledging the need for "appropriate oversight," has complained that there are too many government inspectors and auditors performing overlapping functions; private-sector spokesmen have also argued that industry must devote substantial resources simply to answer all of the government's questions. Some industry sources have cited instances where "up to four different defense organizations are auditing the same functions" and that "they review the same data but refuse to accept each other's findings."[21] The result, industry claims, is lost productivity and profit.

Perhaps one of the best examples of the government's new attitude toward major programs has been the Air Force's Advanced Tactical Fighter project. The program requires development of competitive prototypes by each of the two competing "super" teams (Boeing/General Dynamics/Lockheed and Northrop/McDonnell Douglas). Development of these two prototypes, to be competed in a fly-off in 1990, will be performed under a $691 million firm fixed-price contract that will require each team to invest up to $500 million of its own, nonreimbursable funds. The winning team will then proceed into full-scale development, where they will likely have to invest even more of their own resources before production is begun.

Both industry and government observers have expressed fears that the losing team may be brought to its knees by the heavy investment in an unsuccessful effort and have its future profitability, if not its future existence, put in question. Even the winning team will have to wait several years after production begins before the program begins to show a profit.

Scrutiny of defense contractors has led to an upturn in legal action against defense contractors for alleged fraud and mismanagement. A contractor found in violation of procurement rules, aside from any criminal sanctions against the guilty parties, faces debarment, *i.e.*, loss of the right to bid on federal contracts. This, in the case of a company that relies almost exclusively upon government contracts, as many defense contractors do, can amount to a corporate death sentence.

During the first half of Fiscal Year 1988, for example, a record 284 firms were stripped of their right to bid on DoD contracts, with another 173 temporarily suspended as the result of government investigations. (See Chart 12.) The Pentagon Inspector General reported that the actions had saved an estimated $3.1 billion by challenging dubious contract awards and contract plans. In fiscal 1987, DoD reported that 505 contractors were debarred, a record that is likely to be surpassed in 1988.

Contractors have challenged such negative statistics by pointing to political pressures within the government to cut waste and fraud in order to reduce defense spending. They claim auditors are encouraged to find problems and are seizing upon any irregularity, no matter how small, to make their "quota." In addition, contractors argue that they are denied due process of law by the government's contract debarment procedures.

Key to the last issue is the fact that federal law does not require the government to tell contractors that they are being considered for debarment until the decision has been made. Moreover, the government is not required to state specifically the evidence used against the contractor. Only after the proceedings have run their course can the company argue its case before the agency, and then only under a set of rules established by the agency itself, in essence making it legislature, judge, and jury.

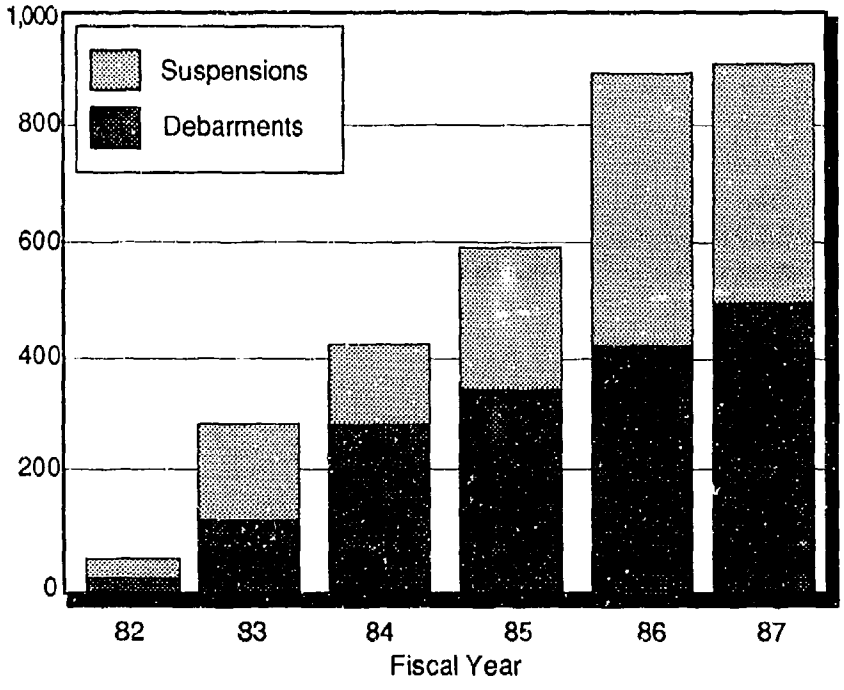
In an effort to make the debarment procedure fairer, the Ad Hoc Industry Advisory Committee of the Senate Armed Services Committee's Subcommittee on Defense Industry and Technology recommended, in a report issued on February 5, 1988, that responsibility for all debarment proceedings be transferred to the United States Claims Court to ensure due process of law for all parties. As of the summer of 1988, the Senate had taken no action on this proposal, and its prospects for consideration looked dim indeed.

Government Reforms

In response to industry's complaints, the federal government has proposed several modifications to acquisition practices, some of which were mentioned earlier, intended to ameliorate relations and restore trust between the government and industry. The Department of Defense has also moved forward with plans to improve the quality of its acquisition programs by streamlining many parts of the process and improving its personnel

CHART 12

DEFENSE CONTRACTOR SUSPENSIONS AND DEBARMENTS



Source: Frank C. Carlucci, Report of the Secretary of Defense Frank C. Carlucci to the Congress on the Amended FY 1988/FY 1989 Biennial Budget (Washington, D.C.: GPO, February 18, 1988), p. 143.

through a series of management reforms.

In the area of improving its management of the procurement process, DoD in 1987 implemented a two-pronged effort to bring about internal improvements by creating the DoD Council on Integrity and Management Improvement (DCIMI) and the DoD Management Improvement Plan (DMIP).

DCIMI coordinates and integrates new management initiatives throughout the department by bringing together top executives from the Office of the Secretary of Defense and the various services, and it issues directed actions on important issues and tracks them until completion.

DMIP maps out priorities for improvements in an annual plan. The Fiscal Years 1988/89 plan sets forth seven goals: (1) simplification and improvement of the acquisition system; (2) linking the mobilization and surge capabilities of the defense industrial base with war fighting requirements; (3) strengthening the direction, coordination, and oversight of DoD financial management; (4) strengthening the management of the DoD health program; (5) improving force manpower and personnel programs; (6) implementing productivity improvements; and (7) improving the efficiency and effectiveness of program management mechanisms. Of principal importance to the defense industrial base are the acquisition reforms because of their direct impact on DoD-contractor relations.

Acquisition Management Reforms

Under DMIP's acquisition management reforms, the Department of Defense has developed eight initiatives to improve its handling of the procurement process. Key among them is the rekindled significance of the Defense Acquisition Board (DAB). The DAB, chaired by the Under Secretary of Defense for Acquisition and vice-chaired by the Vice Chairman of the Joint Chiefs of Staff, "functions as the primary forum for resolving issues, providing and obtaining guidance, and making recommendations" regarding the defense acquisition process.[22] In addition, there are also ten committees within the Defense Acquisition Board that focus on spe-

cific issues and offer recommendations to the Board itself.

Another major Pentagon effort is aimed at cutting the time it takes to procure a weapon system by reducing government interference in the contractor's internal program management. Among other things, this would mean reducing the number of audits conducted by various government agencies, thus allowing the contractor to reduce overhead costs by freeing up personnel otherwise devoted to assisting inspectors.

DoD plans also call for the increased use of "off-the-shelf" equipment, requiring little or no modification, to meet military needs and reduce costs. Successful examples of this include the Chevrolet Blazer used as a light utility vehicle by the Army and the McDonnell Douglas DC/KC-10 Extender aircraft.

Another aspect of this effort is the Non-governmental Standards Program, in which specifications and standards derived from private sector documents are used in place of the often cumbersome Military Specifications (MilSpecs) written by the Department of Defense. Proponents of the use of industry standards claim that this will reduce the paper-work load of contractors and open the way for contractors who, heretofore, avoided defense work because of the complicated and expensive MilSpec requirements. To date, more than 4,000 private sector documents have been adopted for government use, with a target for adding an additional 350 documents per year.

The Defense Department's July 1988 assessment cites strong reasons to avoid MilSpecs wherever possible. "The separation in the industrial base between defense and commercial production is nearly absolute," the report says. "There are few examples of firms that produce both military and commercial products in the same plants. There are firms that serve both markets, but they invariably maintain rigid separation between the two lines of business. These firms, however, do have a more informed view of the difficulties involved in attempting to integrate production of military and commercial products. Their perceptions are that barriers to integration range from immense burdens imposed on defense contractors by government rules and regulations (including, for example, cost-accounting standards that require defense contractors to keep two sets of books) to the unique requirements of thousands of detailed process and product specifications (which frequently are obsolete by the time they are promulgated). In many product and process technologies, commercial practice has surpassed defense practice, with the result that the Department of Defense often pays more for less advanced products."[23]

Technical Manpower

A pervasive problem of the defense industrial base is that the nation's school and university systems simply do not produce enough technically-prepared manpower. The Costello report says that "the basic skill levels of many American high school students are not adequate for the needs of manufacturing firms" and says that enrollment in both undergraduate and graduate technical programs in colleges and universities is insufficient to produce the number of graduates required. It adds that "current data suggest that foreigners may be utilizing our graduate technical programs more than we are (eighty-five percent of the recent growth in technical education has been from foreign students, often on state subsidy and/or federal government grants)."[24]

Millions of new jobs are being created in high-technology and computer fields. The requirement of defense and industry for engineers grows at a rate between 6.1 percent and 8.5 percent a year, and the supply of graduates falls short of that. High school graduates do not get enough math and science. This deficiency carries forward when they go to college. The manpower shortage spans not only most scientific, engineering, and technical specialist fields but also the number of faculty members available and qualified to teach state-of-the-art technology. Naturally, the competition to attract technical talent is fierce.[25]

End Notes

[1] John T. Correll, "The Industrial Substructure: Trouble at the Bottom," *AIR FORCE Magazine,* July 1982.

[2] The Commission on Integrated Long-Term Strategy, *Discriminate Deterrence,* U.S. Government Printing Office, January 1988.

[3] The MAC Group, *The Impact on Defense Industrial Capability of Changes in Procurement and Tax Policy* (Washington, D.C., The MAC Group, February 1988).

[4] Martin Libicki, Jack Nunn, and Bill Taylor, *U.S. Industrial Base Dependence / Vulnerability: Phase II - Analysis* (Washington, D.C.: Mobilization Concepts Development Center, Center for National Strategic Studies, National Defense University, Fort Lesley J. McNair, November, 1987), pp. 3-8.

[5] *Bolstering Defense Industrial Competitiveness, op.cit.,* p. 31.

[6] Testimony before the Subcommittee on Defense Industry and Technology of the Senate Armed Services Committee, March 30, 1988, mimeo.

[7] U.S. Congress, Senate, Report 100-57, 100th Congress, 2nd Session, 1987, pp. 12-13.

[8] Matt Schaffer, "Military Offsets = European Tyranny," *Armed Forces Journal International* (December 1987), pp. 80-85.
[9] "USA May Move to End Offset Deals," *Jane's Defense Weekly* (May 7, 1988), p. 891.
[10] Office of Management and Budget, *Third Annual Report on the Impact of Offsets in Defense Related Exports* (Washington, D.C.: GPO, December 1987), pp. 11-12.
[11] Testimony before the Senate Armed Services Subcommittee, Hearings on Defense Industry and Technology, March 30, 1988, mimeo.
[12] Office of the Under Secretary of Defense for Acquisition, *Defense Science Board 1987 Summer Study on Technology Base Management* (Washington, D.C.: GPO, December 1987), p. 16.
[13] *Ibid.*, p. 9.
[14] *Ibid.*, p. 17.
[15] *Ibid.*, p. 5.
[16] *Discriminate Deterrence: Report of The Commission on Integrated Long-Term Strategy* (Washington, D.C.: GPO, January 1988), p. 46.
[17] *Bolstering Defense Industrial Competitiveness, op.cit.*, p. 21.
[18] The MAC Group, *The Impact on Defense Industrial Capability of Changes in Procurement and Tax Policy* (Washington, D.C.: The MAC Group, February 1988), pp. 6-7.
[19] *Ibid.*, pp. 9-10.
[20] Office of the Assistant Secretary of Defense for Production and Logistics, "MAC Group Study on Profitability - Information Memorandum," March 1988, p. 2.
[21] Sanford N. McDonnell, "The Nation's Defense Industry: Now Too Risky To Be In?" *Wings of Gold* (summer 1988), pp. 11-14.
[22] Frank C. Carlucci, *Report of the Secretary of Defense Frank C. Carlucci to the Congress on the Amended FY 1988/FY 1989 Biennial Budget* (Washington, D.C.: GPO, February 18, 1988), p. 134.
[23] *Bolstering Defense Industrial Competitiveness, op.cit.*
[24] *Ibid.*
[25] Gen. Robert T. Marsh, USAF (Ret.), "Our Dangerous Shortfall in Technical Education," *AIR FORCE Magazine,* December 1985.

4. Raw Materials

Essential to any manufacturing process is the availability of raw materials from which finished goods are made. At its most basic level, virtually every manufactured article requires some raw material extracted from the ground, and seemingly the more complex the article the more likely it is to require scarce materials. The prevalence of numerous high-technology systems in the U.S. armed services means that many of the components critical to national security contain rare materials, many not readily extractable in this country. Many of these materials come from areas of the world that are politically volatile or that are inherently hostile to the United States and therefore unlikely to supply needed raw materials during times of national crisis. Only in molybdenum, magnesium, lead, and copper is the United States self-sufficient or even close to it.[1]

The potential loss of raw material sources has concerned the U.S. design-makers since almost immediately after the Second World War, when the Strategic and Critical Materials Stockpiling Act of 1946 was passed to set up a reserve of materials thought to be critical to any future mobilization. A national stockpile has been in existence, in one form or another, since that time, although it has suffered substantial criticism as being a source of political pork barreling (an issue addressed by modifications made to the program in 1979 and 1980). Unfortunately, the honorable intentions of Congress and various Administrations have not been sufficient either to fill the stockpile to its mandated levels or even adequately determine what its composition should be.

The stockpile currently contains many materials of little or no value to actual surge/mobilization needs and substantial overfills of other materials that are relevant. One reason for this lack of relevance is the uncertainty over the needs of the United States in a national emergency; another is a lack of willingness on the part of government to spend the requisite funds to fill out the stockpile. In the event of a national emergency, the stockpile is expected to support U.S. industry for a period of three years. At present it is not configured to do so. (Charts 13 and 14 show the current goals and levels of fill.)

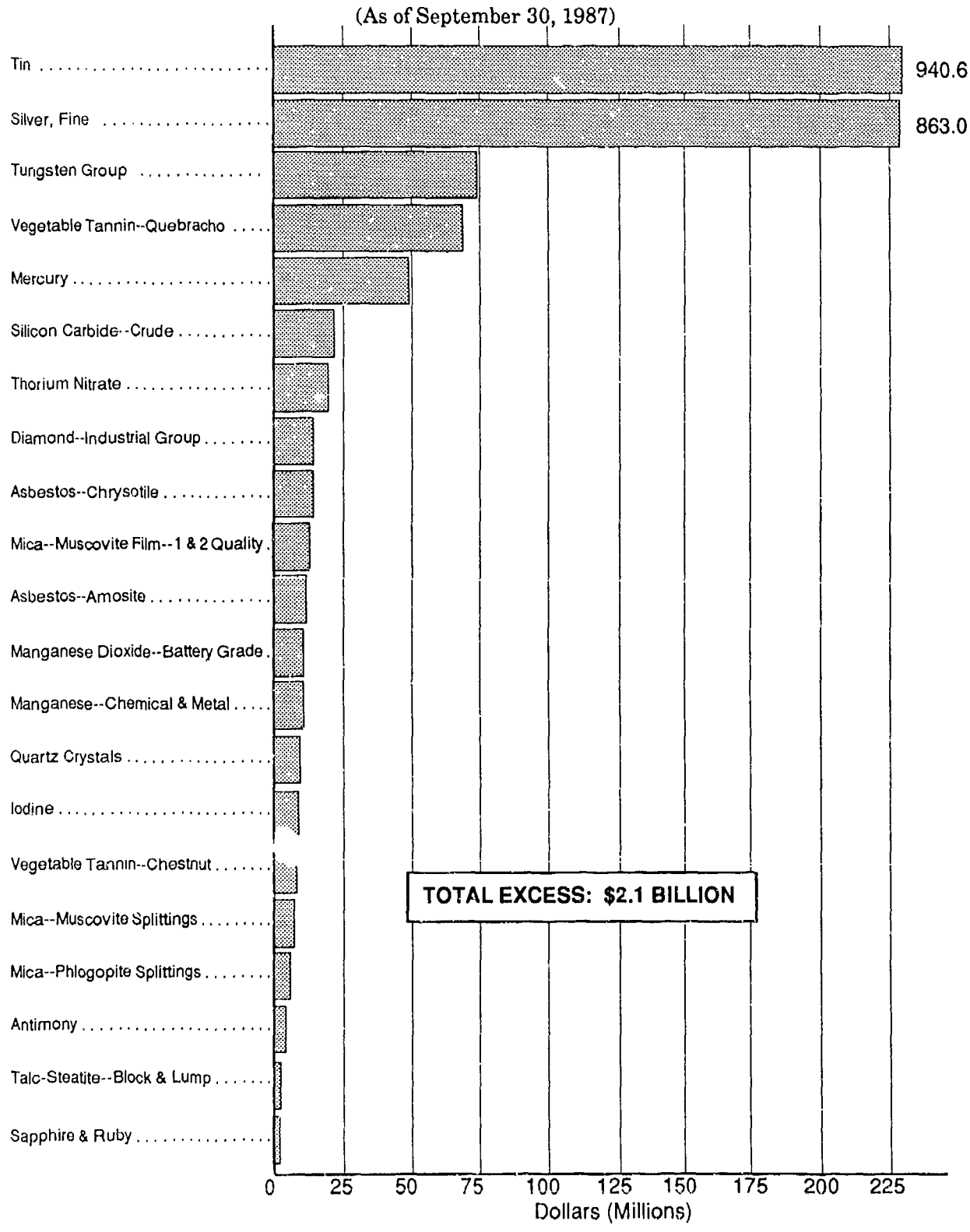
The Department of Defense's responsibility in managing the stockpile program was increased by Congress in the Fiscal Year 1989 authorization, with the Secretary of Defense required to submit an annual report on stockpile requirements to permit better coordination between stockpile assets and mobilization needs. This move followed an attempt by the National Security Council (NSC) and the Office of Management and Budget (OMB) to alter radically the composition of the stockpile based on a widely criticized analysis of mobilization needs issued by the NSC in July of 1985. The NSC recommended that the size of the stockpile be slashed from its total goal of $16.1 billion to only $700 million.[2] A General Accounting Office analysis found the study to be seriously flawed and recommended that no action be based on it. As a result, Congress moved to halt all reductions in the stockpile until October 1, 1987, and instituted several other reforms that placed restrictions on stockpile transactions. Still in place as of the summer of 1988, these restrictions have stifled any action on the stockpile, either positive or negative.

The U.S. mining industry has fallen on hard times in recent years, with demand for its products weakened by cheaper foreign sources and the rising cost of extraction in the United States. The United States has also found itself lacking in many of the materials needed for high-technology products. This decline in the mining industry has damaged national security by making the nation dependent on foreign sources of vital raw materials. In this light it is helpful to examine the "raw materials chain" and its implications for the common defense.

Three steps make up the "chain." First is whether the materials to be mined are indeed present in the United States. Materials not naturally available "in country" must of course be imported or alternative materials found for use in the manufacturing process.

Second is the extraction process. If the materials are not present in a large enough quantity to permit efficient and profitable extraction or their location is such that extraction is too difficult and costly, then the materials are unlikely to be mined in peacetime. During an emergency this could be changed, but the time required to develop the necessary extraction processes is measured in months, if not years, making the new source of little value in any short-term crisis. The presence of large quantities of raw material is of limited immediate value if no means are available to remove them from the ground.

CHART 13



Source: Federal Emergency Management Agency, Stockpile Report to the Congress: April -- September 1987 (Washington, D.C., January 1988), p. 8.

The third step is also subject to serious bottlenecks that are independent of the amount of material present or extractable. If there is insufficient capacity in the processing industry, then the quantity of available processed material cannot be significantly increased during a surge period and will require months or years to mobilize.

The United States suffers from shortcomings in all three steps of the "materials chain." Many of the ninety-five or so critical materials America will need in any future emergency are simply unavailable in minable quantities in the United States. Canada possesses some of these important commodities, including zinc, tungsten, cadmium, and iron ore, but many of the rarer elements are simply unavailable within the North American continent. Two countries with a significant portion of the most scarce materials are South Africa and the Soviet Union, with the Soviets being largely independent of foreign supplies of the critical raw materials that figure in U.S. import vulnerability. For obvious reasons, the Soviets cannot be considered a reliable source of supply. The South African government, while still nominally friendly to the United States, suffers from long-standing tensions between its majority, black population and its minority, white rulers. These tensions, possibly inflamed during times of international crisis by the Soviet Union for its own gain, make it a future source with a high unreliability factor.

U.S. extractive capacity is, naturally, tied closely to the availability of minable materials. Where there are substantial quantities of material the capacity is high, but there is also only a limited capability to surge the level of output. During a surge, however, output could be channelled to necessary industries using a priorities system like those instituted during World War II and Korea. Thus, those few materials being mined in the United States are likely to be in adequate supply. Only foreign-source materials are of major concern.

U.S. processing capacity is, however, more suspect. Many of the materials that the United States imports must also be processed before being ready for use in the manufacturing process. Until recently, most of this processing was done in the United States using the bulk material shipped from the source country. However, many foreign exporters have begun to establish their own processing industries. Since it is more economical to ship the processed materials and since foreign costs tend to be lower than domestic costs, much of this industry has moved offshore or shut down. This means that should the United States be forced to locate alternative sources for raw materials it might not be able to have them processed.

South Africa is the only available source for many of the materials needed for weapons key to national security; Chart 15 shows the Fiscal Year 1987 level of U.S. dependence on South African raw minerals. With domestic U.S. political pressure to cut all trade ties to South Africa growing---and a focus of the Democrats' campaign in the fall presidential election---and the internal stability of that country becoming more tenuous every year, the future security of U.S. minerals supply from that country is threatened. Although efforts are underway to locate alternative sources of these materials, the shifting from one foreign source to another does not in itself guarantee a more secure supply of these vital materials. Political and military threats to sources and the necessary lines of communication will always exist, while the unpredictable nature of these and other factors make any but domestic sources questionable. For this reason, the policy emphasis will be on increasing domestic sources, even though it may be possible to secure outside sources of critical materials during a time of crisis.

Many of the materials on the import South African dependence list are available within the United States, although the quantity available or the difficulty in extracting them makes their production currently infeasible. Alternative sources for the metals on this list are discussed below.[3]

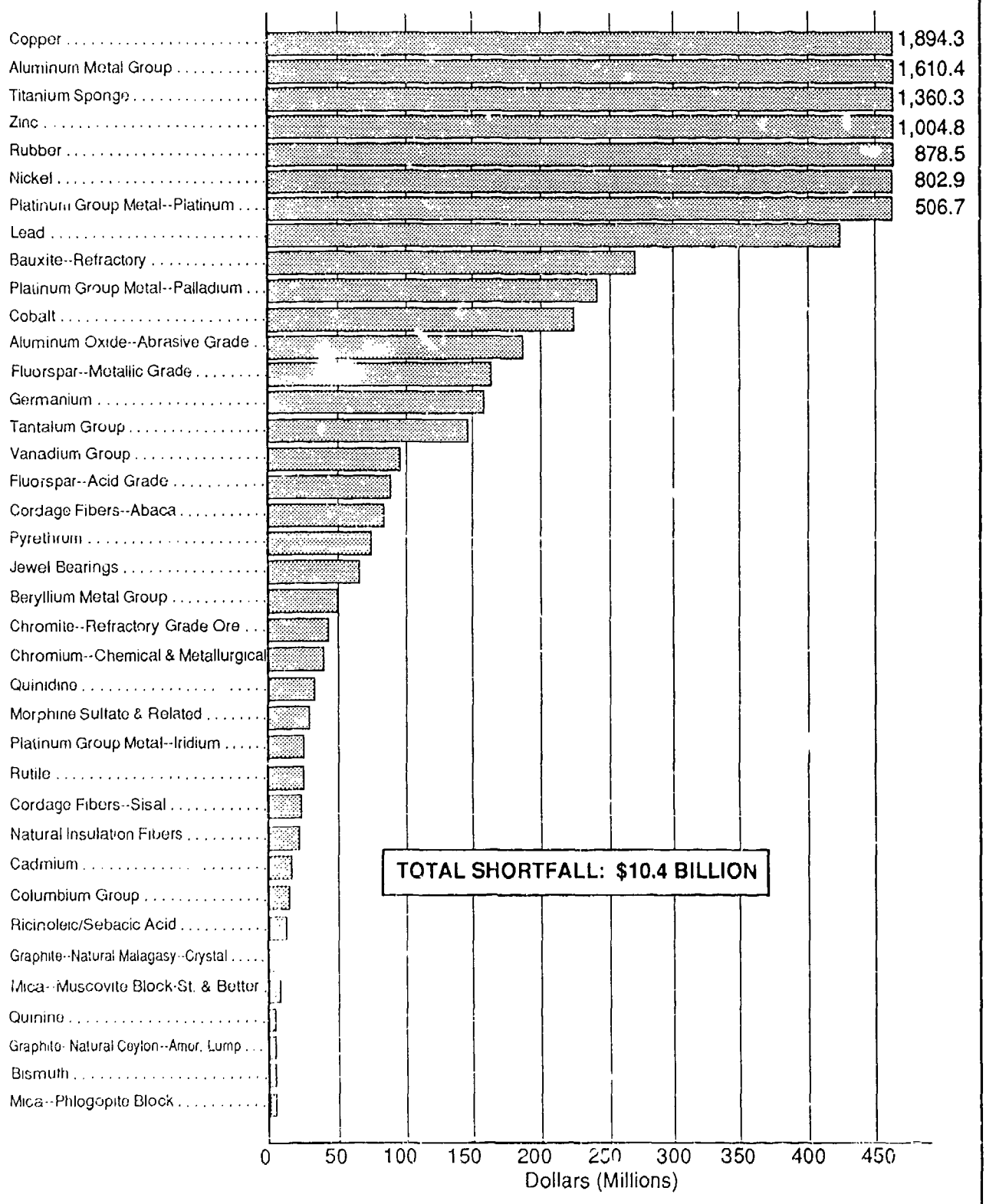
Platinum Group Metals. The United States currently imports virtually all of its requirement of Platinum Group Metals (PGMs include platinum, palladium, rhodium, ruthenium, iridium, and osmium), and 1987 estimates indicate that world production, exclusive of South Africa and the Soviet Union, would provide only twenty percent of U.S. needs. The only U.S. site that produces PGMs, the Stillwater Mine in Montana, can provide only five percent of U.S. needs. Other domestic sources include recovery from other mined ores and reprocessing of scrap. In all, these sources have the potential to provide only fifteen percent of U.S. needs of some or all PGMs during peacetime. Even with tightened usage and elimination of civilian production this would fall short of requirements. Alternative materials for platinum group metals are few, especially for use as catalysts.

Chromium is one of the most vital metals for U.S. national security, being used for metallurgy and various chemical processes. Most U.S. defense consumption is used in making stainless and alloyed steels vital to the aircraft, shipbuilding, and vehicle industries. In 1987, the U.S. imported 400,000 tons of chromium; there is today no domestic production underway because of the lack of economic viability of such extraction. World production levels from nations other than South Africa and the Soviet Union are insufficient to meet world demand, although it would meet U.S. needs, if

CHART 14

SHORTFALLS IN STOCKPILE INVENTORY

(As of September 30, 1987)



Source: Federal Emergency Management Agency, Stockpile Report to the Congress: April -- September 1987 (Washington, D.C., January 1988), p. 9.

CHART 15

DEPENDENCY ON SOUTH AFRICA

Critical Material	U.S. Import Reliance*	South African Imports as a Percentage of Total U.S. Imports
Platinum-Group Metals	88	51
Chromium	75	47
Manganese	100	28
Vanadium	54**	50
Cobalt	86	<1***

U.S. import dependence in selected critical materials from South Africa in 1987.

*Import reliance defined as imports minus exports plus adjustments for government and industry stocks minus consumption. ** 1984 data. For several years, U.S. production data has been withheld to avoid disclosing company-proprietary data. *** Includes exports from Zaire, which uses South African transportation to export its cobalt. Imports from South Africa alone comprise fifty-six percent of total U.S. cobalt imports.

Source: U.S. Department of Commerce data, Mineral Commodity Summaries, 1988. Reprinted in U.S. Congress, House, Committee on Interior and Insular Affairs, Hearings before the Subcommittee on Mining and Mineral Resources, 100th Cong., 1st Sess., Ser. 100-16, p. 162.

indeed all production could be channelled to America, an unlikely event. Alternative sources of chromium are located in Albania, Finland, India, and Zimbabwe. Opening production in other countries with resources would be uneconomic and require several years.

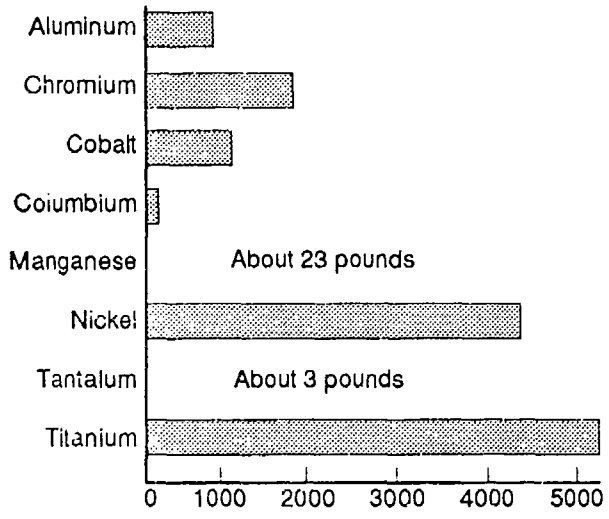
Manganese plays an important part in the alloying of steel and deoxidizing and desulfurizing processes. No known substitutes are currently available for use in steel-making, although research is proceeding on possible alternatives that could reduce consumption by as much as one-third. U.S. consumption totaled 700,000 short tons in 1987, all of which was imported. World production without South African/East Bloc production is 5.8 million tons, about seven times U.S. needs. Primary producer states include Australia, Brazil, Gabon, China, and India. While reserves do exist in the United States, they are of very poor quality and would require at least three years to bring on line.

Cobalt has four primary uses: (1) as a component in heat/corrosion-resistant superalloys used in jet engines, (2) in magnetic alloys, (3) as a desulfurizing catalyst in crude oil refining, and (4) as a binder in tungsten carbide high-hardness, wear-resistant tools. The U.S. imports eighty-five percent of its annual consumption of seventeen million pounds, the rest being provided by recycling. South Africa and the Soviet Union provide only a small percentage of world output, but a substantial portion of world leader Zaire's production is shipped through South Africa. While this could be rerouted or moved by air in a crisis, the reliability and total amount/timeliness of such shipments would drop. There is no currently producing source for cobalt in the United States, although the country does have ten percent of world reserves, that could be tapped given sufficient time and need.

Vanadium is another metal used in producing steel alloys. South Africa and the Soviet Union have eighty-four percent of the world's current production base, although the United States recovers forty percent of its national needs (about fourteen percent of world production) as a byproduct of Venezuelan crude oil refining and an additional small percentage from domestic sources. China has the only other significant producing reserves. Increasing U.S. production of vanadium would be

CHART 16

METALS IN AIRCRAFT ENGINES



Pounds of various metals required for each F100 engine, which powers the Air Force's F-15 and F-16 fighter aircraft.

Source: Air Force Systems Command.

difficult and costly, with U.S. reserves comprising only thirteen percent of world totals.

Gold. U.S. gold production and stocks are more than adequate to satisfy its national security requirements. The principal importer of gold into the United States is Canada, and there is little threat to U.S. requirements during a national emergency.

As a general observation, research is underway in the United States to develop ways to reduce dependence on foreign sources of critical materials and produce substitutes to replace critical materials that cannot be produced domestically. Enhanced recovery and materials processing methods are a prime tool in bolstering the domestic production of critical materials. For example, a new recovery technique has been developed by the Bureau of Mines to extract cobalt from copper concentrates produced from Missouri lead ores. It is hoped that this process could provide up to fifteen percent of U.S. national requirements in the future.

Other possibilities include new efforts in recycling of critical materials. One promising area being explored by the Bureau of Mines involves recovering platinum group metals from automobile catalytic converters, a major consumer of imported PGMs.

Petroleum and Fossil Fuels

Possibly the most vital raw materials needed by the United States today, for both commercial and national security requirements, are fuels. Without adequate supplies of these materials to provide energy for industry and the military, any efforts to increase or even sustain production are doomed to failure. The three most basic fuels used today are petroleum, natural gas, and coal. Fortunately, the United States has substantial national sources of all these fuels, although its petroleum supplies are judged inadequate to meet its wartime need; natural gas supplies are currently thought adequate for national needs. Coal is available in more than sufficient quantities, but has only limited utility due to the conversion of most industries to petroleum or natural gas as fuels. Only in electric power generation is coal a major source of fuel, and even there environmental constraints affect its use.

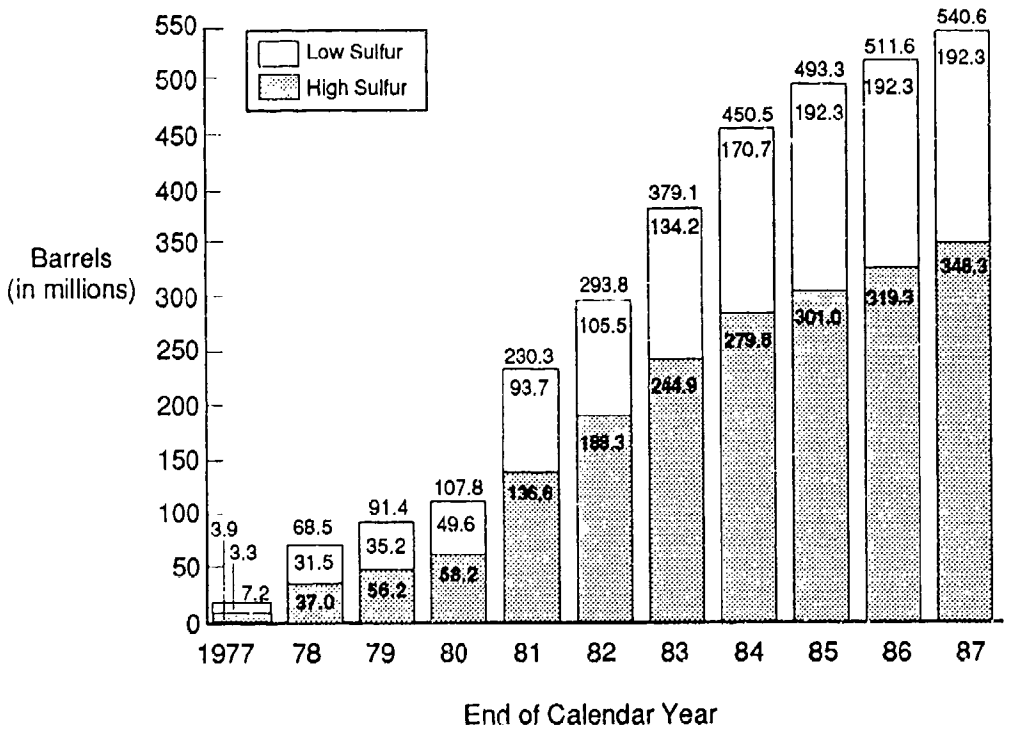
These factors make petroleum the most significant fuel to U.S. national security. It is also the one most likely to be cut off in the event of a national emergency. Although much of the United States' oil comes from North or South America and not the more vulnerable Persian Gulf, it still must travel in tankers across the potentially vulnerable Sea Lines of Communication (SLOCs) where it is exposed to attack. Equally possible are political actions by the South American producing nations and Mexico to cut the flow of oil if U.S. actions displease them, as when the United States supported Great Britain in its war with Argentina. Greater political unity among the South American countries and Mexico could have had a grievous impact on the U.S. economy, in much the same way as the 1973 Arab oil embargo.

Following the 1973 oil crisis, Congress enacted Public Law 94-163, the Energy Policy and Conservation Act of 1975, creating a national Strategic Petroleum Reserve (SPR) of up to one billion barrels of crude to reduce the impact of any future reduction in the nation's oil supply. Currently, the goal for the SPR is 750 million barrels. Chart 17 shows the late 1987 level of fill in the SPR. At the present level of fill, the Department of Energy estimates completion of authorized requirements by the year 2004.[4]

Another source of oil in a crisis are the Naval Petroleum and Oil Shale Reserves located in California, Colorado, Utah, and Wyoming. The three Naval Petroleum Reserves (NPR) are producing fields, completely or partially owned by the government but worked under contract by private industry, while the three Naval Oil Shale Reserves (NOSR 1-3) are undeveloped geologic features containing oil-bearing shale that could be processed into oil. At present no plans exist to begin production of shale oil, but the predevelopment plan for

CHART 17

THE STRATEGIC PETROLEUM RESERVE



Source: Department of Energy, Strategic Petroleum Annual/Quarter Report (Washington, D.C.: GPO, February 15, 1988), p. 7.

NOSR 1, completed in Fiscal Year 1982, is being maintained and updated in the event that the decision to undertake production is made.[5]

As part of its Fiscal Year 1988 budget submission, the Reagan Administration included $3.3 billion in revenues from the sale of NPR-1. The decision to sell the reserve was in keeping with Administration policy to "privatize" as many government-held assets as possible, but congressional resistance, supported by the armed forces, blocked the proposed sale. Defense officials feared that the loss of the reserve would threaten their ability to obtain liquid fuels in times of national crisis, especially during the early stages of any supply disruption, before the SPR becomes fully available.

While the presence of the reserves mitigates some concerns about the possibility of an oil embargo, it does little to relieve concerns about the current state of U.S. oil production. Since the collapse of oil prices in 1985--1986, American oil production and exploration levels have fallen dramatically, as oil imports and consumption rose. In mid-May 1988, the United States imported 6.3 million barrels of oil daily, compared to a figure of 5.2 million barrels per day a year earlier; the country produced 8.1 million barrels and 8.3 million barrels per day, respectively.[6] During May 1988, a total of 883 rigs was exploring for oil in the United States, down from the record high of 4,500 in December of 1983; 941 rigs were operating just a month before, in April 1988.[7] In Oklahoma alone, 50,000 energy-related jobs were lost between 1983--88, and unemployment levels there and in adjoining states exceeded thirteen percent.[8]

Not only is the quantity of crude oil produced or imported important but the nation's capability to refine oil is also a major factor of uncertainty. In May 1988, U.S. refinery utilization levels were at more than eighty-five percent of capacity. This means that any future increase in national requirements would be limited as to the amount of growth available in refining capacity, which is marginal at best.

Since the end of the oil crisis in the early 1980s, consumption in the United States has grown steadily, fueled by lower oil prices. As prices dropped,

interest in conservation and alternative energy sources has waned, and once promising efforts in synthetic fuels fell by the wayside. U.S. import levels in 1988 have reached forty percent of national consumption and domestic production is declining. Conditions are once again close to where they were in 1973, with the nation vulnerable to having its petroleum lifeline cut. Should this happen in conjunction with a national emergency requiring surge or mobilization of the defense industrial base (as is easily possible), the resulting energy shortages could be disastrous, severely affecting America's ability to defend itself and its allies.

In order to meet this threat, the United States must again examine alternative energy sources such as oil shale, coal gasification, heavy oil recovery, and renewable sources of energy such as alcohol and biomass. Several of these projects, left over from the scares of the 1970s, are still in operation or under development today. Even if production of these fuels is uneconomic under current conditions, the government should develop these processes to the limits possible and retain them and the necessary facilities in a national reserve to be used when needed. Unfortunately, in an era of tightening purse strings, government financing of projects such as these is highly improbable, especially in an election year.

Another, even less politically attractive alternative is to impose import fees on oil to encourage domestic exploration and production, as well as conservation. However, such an action would drive up the cost of heating fuel oil, gasoline, and other petroleum products, thus angering consumers, a move unlikely except in the most urgent of situations.

Solutions By Substitutions

A mitigating factor in materials shortages and dependencies---and perhaps one of the best solutions when it can be applied---is substitution. Composites and other new materials are already in widespread use in newer weapon systems, and the trend is clearly in that direction. Forecast II, Air Force Systems Command's long-range view of the future, lays great emphasis on advanced materials. They also are used increasingly in systems currently in development.

"In our work on lightweight, high-temperature advanced materials for engines and airframes, we are moving away from superalloys that contain critical strategic materials," says Norman Tallan, Chief of the Aeronautical Systems Division's Materials Laboratory at Wright-Patterson AFB, Ohio.

Research on these advanced materials relies upon intermetals---such as titanium aluminide---and with carbon carbon and composite materials. None of these involves cobalt or chromium. Both of those substances figured heavily at one time in the building of high-temperature fighter engines. They were classified as critical strategic materials, and the sources of supply were abroad. New technology has taken some of the edge off the strategic materials problem.

"The cost and availability of cobalt and chromium from the Soviet bloc countries was a major concern at one time, and we began looking for ways around them," says Mr. Tallan. "That concern has eased drastically. It may be cyclical, though, just as supplies of oil may be. The issue may come back."

If it does, ingredients of intermetals and other materials may by then have taken the place of the so-called superalloys. Titanium and aluminum are big in this, for example, as are beryllium and niobium. Even today's high-performance engines have moved away from cobalt and chromium and rely mostly on superalloys of nickel, a metal that is in rich supply.[9]

End Notes

[1] Emil A. Romagnoli, "Statement of the American Mining Congress on the Defense Industrial Base Before the House Committee on Banking, Finance, and Urban Affairs Subcommittee on Economic Stabilization," September 29, 1987, mimeo.

[2] U.S. General Accounting Office, *National Defense Stockpile: National Security Council Study Inadequate to Set Stockpile Goals* (Washington, D.C.: GAO/NSIAD-87-146, May 4, 1987).

[3] All statistics for the sections below are derived from: U.S. Congress, House, Committee on Interior and Insular Affairs, *Hearings* before the Subcommittee on Mining and Natural Resources, "Statement of David S. Brown, Acting Director, Bureau of Mines," December 10, 1987, pp. 152-179.

[4] U.S. General Accounting Office, *Oil Reserves: An Analysis of Oil Fill Alternatives* (Washington, D.C.: GAO/RCED 87-145BR, May 21, 1987), p. 17.

[5] U.S. Department of Energy, *Naval Petroleum and Oil Shale Reserves: Annual Report of Operations FY 1987* (Washington, D.C.: Office of Naval Petroleum and Oil Shales Reserves, USDOE, 1987), p. 34.

[6] American Petroleum Institute data, 1988.

[7] "U.S. Rig Count Down," *New York Times,* May 17, 1988, p. D11; "Rig Count Up in Week," *New York Times,* April 5, 1988, p. D9.

[8] U.S. Congress, Senate Committee on Finance, *Hearings* on S. 1871, 99th Congress, Second Session, August 13, 1986.

[9] James W. Canan, *AIR FORCE Magazine* interview with Norman Tallan, August 2, 1988.

5. Key Segments of the Base

This section highlights selected areas of the American defense industrial base. Most of the industrial sectors covered here have suffered substantial declines in market share and technological leadership during the past two decades. Leading contributors to this decline have been the growing "globalization" of the nation's economy and the rising technological competence of the rest of the world.

In the years following the Second World War, the United States enjoyed undisputed leadership in manufacturing and innovation, being, as it was, the only major country to have been spared the depredations of the war. However, during the forty-three years since the end of hostilities, the devastated countries have enjoyed a renaissance of sorts, establishing new industries and completely rebuilding old ones. The United States' foreign competitors were unfettered with aging equipment and ideas, and they were free to adopt new and innovative concepts to make their industries competitive against the aging U.S. industrial giants. Foreign industry's need for massive capitalization and protection from other, primarily U.S., competition also fostered substantial government participation, including, in many cases, government ownership of large shares of these industries.

In the United States, industry's management and labor, complacent about the nation's seemingly unchallengeable lead, failed to keep pace with the rising tide of technological and managerial innovation, as measured by productivity growth, espe-

CHART 18

PROFIT COMPARISONS BY INDUSTRY

(Percentages)

Industry Composite	Return on Equity (Twelve Months) 1986	Profits as a Percentage of Sales Third Quarter 1987	Third Quarter 1986
Aerospace	9.6	3.5	3.0
Appliances	14.9	4.4	4.8
Automotive	14.2	3.9	2.5
Conglomerates	10.1	6.7	NM
Drugs	21.2	12.9	12.1
Electrical & Electronics	12.1	5.2	4.0
Food Processing	19.0	4.2	4.3
Metals/Mining	5.4	9.6	3.4
Office Equipment & Computers	11.5	7.9	6.7
Oil Service & Supply	-23.8	6.5	NM
Publishing & Broadcasting	18.5	9.6	10.5
Retailing, Nonfood	14.2	2.5	2.3
Steel	-28.0	3.2	NM
Textiles & Apparel	12.9	5.2	4.6

NM = Not Material

Source: 1986 results: Business Week "Top 1000" (April 1987); Third Quarter results "Corporate Scoreboard," Business Week, November 16, 1987.

CHART 19

COMPARING PRODUCTIVITY GROWTH

(Index: 1977 = 100.0)

Year	United States	France	West Germany	Japan	United Kingdom
1960	62.2	36.4	40.3	23.2	55.5
1961	64.0	38.5	42.2	26.3	55.5
1962	66.7	40.9	45.1	27.4	56.8
1963	71.2	42.8	47.0	29.6	59.7
1964	74.6	46.0	50.9	33.6	63.7
1965	76.6	49.2	54.0	35.0	65.7
1966	77.4	53.1	56.3	38.5	67.8
1967	77.4	56.3	60.1	44.2	71.0
1968	79.8	62.3	64.9	49.8	76.2
1969	80.8	65.8	69.1	57.5	78.0
1970	80.8	69.6	71.2	64.8	79.7
1971	85.3	73.3	74.0	68.6	83.5
1972	89.0	77.7	78.9	75.3	89.1
1973	93.4	82.2	84.0	83.1	95.6
1974	90.6	85.2	87.4	86.5	97.4
1975	92.9	88.5	90.1	87.7	95.2
1976	97.1	95.0	96.5	94.3	99.5
1977	100.0	100.0	100.0	100.0	100.0
1978	101.5	105.7	103.1	108.0	101.5
1979	101.4	110.3	108.2	114.8	102.4
1980	101.4	112.0	108.6	122.7	101.7
1981	103.6	116.4	111.0	127.2	107.0
1982	105.9	123.5	112.6	135.0	113.6
1983	112.0	128.8	119.1	142.3	123.0
1984	116.6	133.8	123.5	152.5	129.5
1985	121.7	138.3	128.9	163.7	134.2
1986	126.0	140.9	168.2	168.2	138.2

Productivity in manufacturing sectors of selected countries, growth measured by output per worker-hour. Data for 1986 are estimates.

Source: Department of Labor, Bureau of Labor Statistics, Office of Productivity and Technology, June 1987.

cially after 1975 (see Chart 19). As early as the 1960s various countries, with West Germany and Japan being the most prominent, began to penetrate U.S. markets with low-priced, high-quality goods. By and large, U.S. industry failed to meet these challenges through increasing domestic productivity and innovation. Other factors in the decline of U.S. industry included the high value of the dollar, which made American goods expensive in foreign markets; the shortsightedness of corporate planners; and the skyrocketing inflation of the post-oil crisis of the mid-1970s.

In his assessment of 215 industries that accounted for some ninety-five percent of DoD purchases during 1980--1985, Under Secretary of Defense (Acquisition) Robert Costello concluded that the trends are "disturbing, particularly with respect to indicators of future productivity and competitiveness."

The Costello report says that between 1980 and 1985, the 215 defense-critical firms were below the U.S. average in productivity growth, capital investment, and additions to their productive capacity. It further states that these companies achieved average or above-average profits during the period in question.[1] That assessment of the profitability of defense contracting seems to be at odds with other indications.

In a 1985 study called DFAIR, the Department of Defense concluded that defense contractor profits were generally comparable with those for commercial firms. (DFAIR stands for Defense Financial and Investment Review.) Later studies by the General Accounting Office (GAO) and the Navy disagreed, claiming that defense profits were higher than the norm. Then the Financial Executives Institute (FEI)---an organization of senior financial officers in more than 6,000 companies---evaluated all three studies. FEI concluded that the DFAIR product was a sound piece of work, but that the GAO and Navy studies had fundamental flaws.[2]

Another indication is that, with only a few years to the exception, the Standard & Poor's Aerospace price/earnings index trailed the Standard & Poor's 400 index by a substantial margin between 1962 and 1987.[3]

Machine Tools

After fuel and raw materials, perhaps the most important sector of the U.S. economy as far as national security interests are concerned is the machine tool industry. Even in peacetime one-quarter of the nation's machine tool consumption is related to national defense requirements, making the industry, in the words of President Reagan, "a small yet vital component of the U.S. defense base."[4] Machine tools shape, form, or process metals into other machines or components for weapons, and without them manufacturing of any kind would be impossible. During both world wars and Korea, a shortage of machine tools proved to be the most serious constraint to expanded production in all segments of the defense industry, since these tools were required for manufacturing tanks, planes, ships, vehicles, and virtually all other militarily significant items.

This vital segment of the American defense industrial base, however, has been shrinking during the past decade because of foreign penetration into the U.S. market, which increased from about seventeen percent in 1977 to nearly fifty percent during 1986.[5] Industry spokesmen claim that this loss of market share was the result of targeting by foreign industry and governments, or as claimed, "selectively impeding foreign competition in the home market, directly financing research and development, granting concessionary loans and special tax benefits, and restricting technology transfer."[6] In an attempt to counter what it considered unfair trade practices, in 1983 the National Machine Tool Builders Association, a lobbying group for machine tool makers, filed a request for relief under Section 232 of the Trade Expansion Act of 1962. This statute provides for government or private groups to file petitions seeking an investigation of the effect of foreign trade practices on national security.

After a three-year interval, during which twenty-five percent of the U.S. machine tool makers in business in 1983 closed, were bought out by other concerns, or moved their operations offshore, the government responded to the petition and opened negotiations with the principal exporters of machine tools to the United States. The result was a 1986 five-year Voluntary Restraint Agreement (VRA) with Taiwan, Japan, West Germany, and Switzerland restricting their exports of high-technology machine tools to the United States. The government also responded to this threat to national security, albeit belatedly, by establishing in 1986 the Machine Tool Domestic Action Plan to help the industry recover during the five years of the VRA. The major parts of the plan include:

o Budgeting $5 million to support the National Center for Manufacturing Sciences (NCMS), a private research and development venture sponsored by machine tool makers and other manufacturers founded in November 1986. NCMS will: (1) set a national manufacturing research agenda, (2) develop manufacturing and material process concepts, (3) facilitate the transfer of research results, and (4) establish a manufacturing science data source.

o Sponsoring a government/industry conference to define potential machine tool research projects to improve manufacturing technology.

o Designating the machine tool industry as a separate area of interest under the DoD Manufacturing Technology (MANTECH) program.

o Providing the industry with an eleven-volume index of machine tool-related research and development available from the government in order to help the industry to modernize.

The early results of these efforts have been positive, with an overall increase in orders since 1983, and with 1988 orders substantially increased above those of the previous year. Orders placed in the first quarter of 1988 were nearly eighty-four percent higher than for the same period in 1987, and the foreign share of the U.S. market is down to thirty percent from almost fifty percent in 1986.[7]

In spite of these recent successes, the future of the industry will not be known until the VRAs are removed in 1991 and U.S. machine tool makers face the full competition of international trade. Only then will tool makers discover whether their advances in technology and efficiency have enabled them to compete on an equal basis with foreign industry. Should they not meet the test, the U.S. government will have to decide how or whether to shelter further this crucial sector of the defense industrial base. Without a strong national machine tool industry as the foundation of any future industrial mobilization, the national security of the U.S. will be seriously diminished.

The Aerospace Industry

The U.S. aerospace industry, while in far better shape than many other key industrial sectors, is nonetheless facing serious questions concerning its future orientation. Globalization and foreign penetration are just now beginning to be felt within the industry. Foreign-made aircraft, both commercial and military, are giving U.S. manufacturers serious competition in the international marketplace as well as at home. Examples of the former include the 1987 sales of French Mirage 2000 jets to Jordan and the Panavia air defense variant to Saudi Arabia (after sales of U.S. aircraft were blocked by Congress).

In the latter instance, the selection by the U.S. Navy of a British Aerospace Hawk variant, to be known as the T-45 Goshawk, as its principal jet trainer marks the first recent major purchase of a foreign-designed aircraft. British Aerospace teamed with McDonnell Douglas on the project in a joint venture to penetrate the U.S. market. The $16.8 million Goshawk will be assembled by McDonnell Douglas with substantial British input.

The increasing globalization---or internationalization---of the aerospace industry is reflected in the joint ventures undertaken by U.S. firms, licensing of U.S. products to foreign manufacturers for overseas production, and direct investment by foreign companies in domestic firms. Joint ventures are, by far, the most common type of internationalization, being favored by both company executives and governments.

U.S. industry views joint ventures as an important method of gaining or maintaining access in foreign nations, especially those with competitive aerospace industries of their own. While tariff barriers on civilian commercial aircraft were dropped in 1979 with the signing of the Civil Aircraft Agreement, foreign buyers still exhibit, as do U.S. customers, a preference for aircraft produced in their own countries. Government and defense leaders therefore see joint ventures as a means of reducing the cost of aircraft and system acquisition as well as cementing relationships with allies and improving force interoperability.

On the other hand, joint ventures can strengthen overseas partners by opening to them access to advanced technology and methods that may tranform them into direct competitors. In the past, most joint ventures tended to consist of a dominant partner and one less technically advanced. Such transfer of knowledge was encouraged by U.S. leaders in the post-World War II period in order to develop the aerospace industries of allied nations, help their economies, and reinforce Western defense posture. In the last ten years, though, these foreign firms have begun to compete effectively with the United States in world markets. This has given rise to concerns that it is no longer in this nation's best interest to encourage technology transfers that may lead to further loss of business.

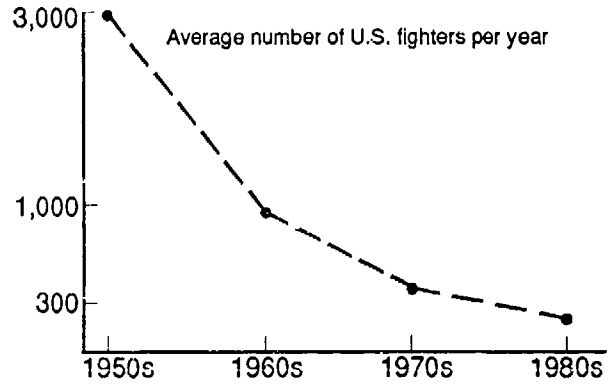
Another result of internationalization in aerospace has been a global surplus of aircraft production capacity. This creates fierce competition among aircraft makers to hold or improve their share of an increasingly soft market. Even without the element of a challenge from abroad, domestic producers would still be contending more than previously with each other for business. For a variety of reasons, the average number of fighter aircraft bought by U.S. armed forces per year has been falling sharply since the 1950s. (See Chart 20.) The competition for fighter contracts was already tight, and the round of reductions to the defense budget that began last winter will probably tighten it further.

In addition to joint ventures, another way that U.S. aerospace technology is acquired by for-

eign firms is through licensing agreements, in which U.S.-designed aircraft are built overseas. While these aircraft include varying levels of U.S. subcomponents, the technology to manufacture the complete aircraft is made available---for a price, of course---to the licensee. This can not only train the licensee to be a direct competitor but also raises the question of national and technological security.

CHART 20

TOWARD AUGUSTINE'S THEOREM



Norman R. Augustine, who has seen defense acquisition from many perspectives, observes that, given the prevailing trends and resources likely to be available, the Defense Department will be able to buy only one aircraft annually by the year 2025. (The wise and witty Augustine admits that the single aircraft will be a very impressive one.) A logical extension of the data says that Augustine's famous prediction may not be far off.

Source: Dr. Jacques Gansler, "The Dangerous Dive in Aircraft Production," AIR FORCE Magazine, December 1986.

The wisdom of such transfer of information, especially where sensitive technology is involved, has become a matter of intense debate. Many manufacturers think that U.S. technology transfer laws are too restrictive and hurt their ability to compete overseas. Others, particularly in government, worry about the potential breach of security, citing the loss of advanced submarine propeller quieting technology in the 1987 Toshiba and Kongsberg Vaapenfabrik cases.

Other disadvantages of licensing are a small end profit for the company, the lack of information flowback from the licensee, and---if one assumes that the procurement would have taken place anyway and would otherwise have been a straight export---the loss of wages and taxes generated by domestic manufacture.

On the positive side, licensing means a smaller capital investment by the licenser, a reduced requirement for administrative personnel, and often a quicker---though smaller---return on investment. (This is because many licensing agreements call for up-front payments of fees and royalties). Because of these and other factors, such as the maintenance of good relations with friendly nations, the lucrative practice of licensing aerospace products for foreign manufacture will probably continue with the government's blessing for as long as there is a foreign market.

Foreign nations engage in joint ventures with each other as well as with the United States. The multinational Tornado is an obvious and highly successful example, but consider also the Royal Air Force's new basic trainer: a variant of the Brazilian Embraer Tucano, with Garrett of the United States and Rolls-Royce of the UK teamed to provide the engine and production underway by Shorts in Northern Ireland.

Sound perspective requires that the trend toward internationalization be viewed in the context of a military aerospace market previously dominated by the United States. Today, seventeen foreign nations have bought the F-16. Three operate F-15s. Sixty fly the C-130 airlifter. Sixteen have the Maverick missile. Ten fly F-4 Phantoms.

Maritime Industry

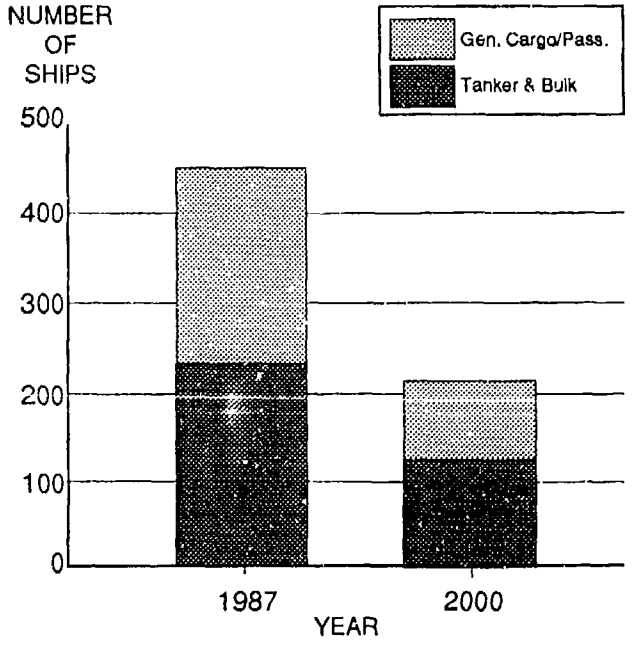
Although much "lip service" has been paid to the importance of the U.S. maritime industry since the passage of the watershed 1936 Merchant Marine Act, very little has been done to preserve it. Noble words such as those of President Reagan spoken at the May 1987 dedication of "National Maritime Day" do little to aid the dwindling maritime base of the nation: "During peacetime, the merchant marine has linked the United States in commerce with trading partners all over the world. In times of war or national emergency, merchant seamen have served with valor and distinction as the lifeline of our armed forces. The dual roles of the merchant marine in trade and defense remain crucial to our national interests, so the maritime policy of the United States must always keep it strong and competitive."[8]

Regardless of these sentiments, the current state of the U.S. maritime industry can be summarized succinctly: disastrous and heading downhill. At the end of the World War II, the United States had the largest merchant fleet in the world; there were still 2,332 U.S. oceangoing ships active in 1947, as well as the world's largest shipbuilding

industry. Forty years later, the number of U.S.-flag merchant ships had declined to just 369 active vessels (with another 100 laid up, mostly for economic reasons). The U.S. merchant marine is expected to fall to 220 ships by the year 2000 (see Chart 21).[9]

CHART 21

U.S. FLAG MERCHANT FLEET
(Oceangoing, privately owned vessels)



Source: Commission on Merchant Marine and Defense, First Report of the Commission on Merchant Marine and Defense: Findings of Fact and Conclusion (Washington, D.C., September 30, 1987), p. 34.

Furthermore, all that is sustaining life in America's shipbuilding base are Navy contracts---no oceangoing merchant ship has been under construction in a U.S. shipyard since the end of 1987, and no new orders are in sight---and the number of shipyards has fallen from 110 in 1982 to sixty-nine in July 1988, with more closings expected. (The reliance on Navy shipbuilding and conversion to keep these yards going in the future is fraught with danger, as current projections of flat if not decreasing defense budgets for the remainder of the century pose grave problems for the industry.) The strategic dimensions of these losses become even more dramatic and destabilizing for U.S. security when one considers the enormous economic impact on people. From January 1978 to January 1988, there was a direct loss of 45,000 shipbuilding jobs, as well as numerous others in supporting areas.

The United States simply does not have the capability to sustain even its peacetime merchant shipping needs using only American flag vessels and is swiftly losing the facilities to build new ships and repair old ones. Furthermore, along with the loss of merchant ships has come a loss of trained merchant seamen, which will be more difficult to overcome. Many of those currently employed aboard U.S.-flag ships are over the age of fifty, and few new seamen are being hired (see Chart 22), with the current pool of 29,000 U.S. merchant mariners considered barely adequate to meet peacetime needs. In the event of a mobilization, the nation would need 4,500 men to man its small Ready Reserve Force of some 100 ships, which, when added to the increased needs of commercial merchant shipping, leaves the nation short by some 2,000 seamen.[10] The shortage is expected to worsen.

Government and industry failed to respond to foreign actions to secure markets for their shipping and shipbuilding industries. Thus, U.S. operators and shipyards were shut out of the overseas markets and had domestic markets wrestled away by cheaper, more modern, and more aggressive foreign competition.

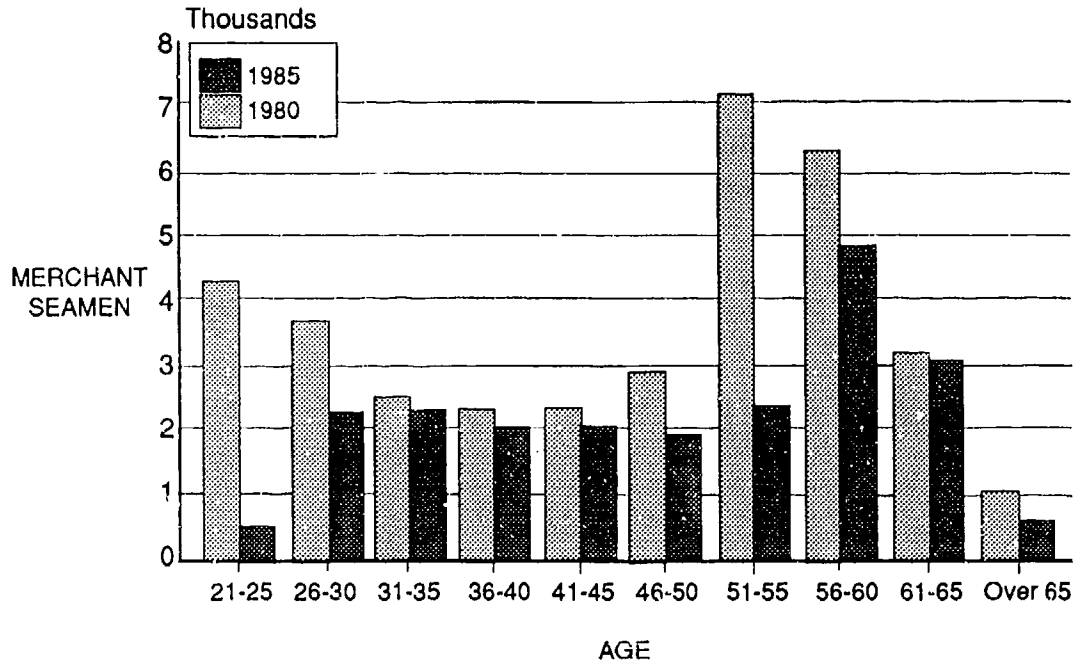
In the event of a future surge/mobilization, the nation would need merchant shipping for two principal purposes: (1) to move U.S. troops and/or supplies to overseas destinations, and (2) to import finished goods and raw materials from foreign sources to support the U.S. industrial base. It is obvious that the U.S. merchant fleet, even when augmented by domestically owned ships flying flags of convenience, about 134 useful ships in 1987 (a number that has since decreased), is incapable of meeting the country's needs.[11] According to Gen. Duane H. Cassidy, USAF, Commander, United States Transportation Command, U.S. sealift assets are inadequate to meet the needs "of even a single theater conflict."[12] To meet its requirements the United States would have to rely on the merchant shipping of its allies, which is rapidly declining in numbers, and upon "mercenary" shipping hired from the open market. The wisdom and practicality of doing this is open to debate, with one side claiming that reliance upon foreign ships, even those of our allies, places the nation in an untenable position. Nevertheless, the other camp argues that commercial shipping will always be available, for a price, regardless of political issues.

Advocates of a larger U.S. merchant fleet point out that the nation would be at the mercy of foreign powers should the United States ever find itself in need of merchant shipping to support national interests in a politically controversial situ-

CHART 22

MERCHANT MARINER AGE DISTRIBUTION

(Active on oceangoing ships 1980--1985)



Source: Commission on Merchant Marine and Defense, First Report of the Commission on Merchant Marine and Defense: Findings of Fact and Conclusion (Washington, D.C., September 30, 1987), p. 34.

ation, such as a war in the Middle East. The inability of America to obtain shipping from nations opposed to U.S. policies and actions could cause these initiatives to fail, perhaps forcing the government to modify its actions to placate foreign governments. As one U.S. government panel acknowledged, "Let there be no doubt that this nation can no longer view the U.S.-flag merchant marine and our maritime industries as 'nice to have.' A failure to revitalize the industries...may be a grave blow to the nation's security in the future."[13]

Those in the opposite camp contend that the open marketplace would provide all the shipping that the United States would need and that any efforts to bolster the domestic shipping and shipbuilding industries, which obviously are too inefficient to survive in a free market, would be a waste of money and ultimately counterproductive. Proponents of subsidizing the U.S. merchant marine point out, however, that the ideal "Free Trade" really does not exist and that foreign governmental restrictions and subsidies promote discrimination and protectionism and restrict the ability of U.S. carriers to compete "fairly" and "freely" in foreign markets.

Nevertheless, forces in the U.S. shipping industry and Congress are working to resurrect the U.S.-flag merchant fleet and related industrial base. The Commission on Merchant Marine and Defense, chaired by former Senator Jeremiah Denton, began work in December 1986 by Congress with the mandate to examine the problem and develop recommendations for future courses of action. In its recommendations issued in late 1987, the Commission included the following:

- That Congress enact a meaningful Operating Differential Subsidy reform package to "ensure more flexible and competitive United States-flag carrier service" and sustain and expand the capability of merchant marine to meet the nation's sealift needs.

o That a "Procure and Charter" program be instituted that would lead to the procurement of "commercially viable yet militarily useful dry and liquid cargo ships." The Commission recommended that legislation be enacted in fiscal 1989 to build "at least twelve [ships] per year over a ten year period" with a goal of increasing the U.S.-flag active and ready reserve fleet to 650 ships.

o That the government create "more equitable competitive conditions" for U.S. ships and work to increase the percentage of the nation's goods carried in U.S. bottoms to "at least eight percent within ten years."

The Commission reported a total of twenty-four findings and conclusions, almost none of which shed a positive light on the state of the U.S. maritime industry. Despite the warnings of the Commission and other experts from academia and industry, the response from Congress has largely been to continue to ignore the question, in essence almost hoping it will go away. The unfortunate aspect of such fence-sitting is that in a few years the "problem" will be gone---perhaps permanently.

The Pharmaceutical Industry

Shortage of medicines would have a very significant impact on mortality rates among military personnel and civilians in wartime or in the event of a major natural disaster. Yet this area is often overlooked when surge or mobilization requirements of the U.S. industrial base are discussed. During a time of war or other emergency, the need of the U.S. armed forces for medicines and medical supplies would be greatly increased. This need would be in addition to civilian requirements, both those of the U.S. population and of foreign nationals in war zones. Many of today's advanced medicines are very complicated to manufacture and require special handling after manufacture, having very specific shelf lives and storage procedures.

In order to help manage the needs of military medicine---the discussion here being restricted largely to military needs, as civilian requirements in the event of a natural disaster are reasonably similar---the Federal Emergency Management Agency (FEMA) has established a list of critical pharmaceuticals. It is these drugs that will be the focus of this discussion.

The U.S. pharmaceutical industry is currently being buffeted by the same trends that have affected other manufacturers in the country, including foreign competition, movement of industry offshore, and foreign acquisitions. A recent FEMA study of the industry pinpointed the following trends in the industry:[14]

o The movement of the final drug processing stages overseas to the countries where a drug will be consumed.

o The general shift in U.S. emphasis to the high-technology, biomedical sectors of the market, while basic pharmaceutical production moves to more cost-effective areas overseas.

o The increased purchase of both pharmaceutical raw materials and manufactured items by U.S. companies from foreign sources.

o The concentration of major domestic firms that invest heavily in R&D on smaller runs of high-value drugs at the expense of high-volume capacity at those firms.

o The movement to flexible plant designs, which allow for the rapid shift of production from one drug to another.

In addition to these issues, FEMA has identified several critical bulk drugs used to make the finished dosage drugs actually used and for which there are no apparent U.S. suppliers. These include atropine sulfate, epinephrine hydrochloride, diazepam, and furosemide. For bulk tetracycline, digoxin, diphenhydramine HCl, ether, insulin, and morphine sulfate, there is only one U.S. source.[15] The threat of foreign dependency for bulk drugs and also replacement manufacturing equipment, which largely comes from West Germany and Italy, is potentially serious. While Canada has been identified as a major source of bulk drugs, no reliable data was available to determine what percentage of U.S. mobilization needs could be met north of the border.

The ability of U.S. manufacturers to surge drug production is, however, estimated to be quite high, despite the foreign dependency question, with a moderate amount of excess capacity currently available (most companies run production lines for only one or two shifts a day, five days a week). Current DoD projections indicate that in all but a few instances the industry can meet military pharmaceutical requirements within four to six months of mobilization.[16]

The Semiconductor Industry

Of all the sectors of the U.S. economy hurt by foreign penetration into its markets, the semiconductor industry is possibly the most prominent, and its situation has been publicized more widely.

The rapid decline in the U.S. semiconductor industry has caused deep concern among many observers. They fear that the United States will soon be forced to depend upon foreign sources for many

or all of its military semiconductor needs. While many advocates of free trade laud the working of free market economy, others point to the potential impact of the nation losing its leadership in semiconductor manufacturing. The 1987 Defense Science Board study of semiconductor dependency concluded that the United States needed to retain a healthy industry because:[17]

o U.S. military forces depend heavily on technological superiority to win.

o Electronics is the technology that can be leveraged most highly.

o Semiconductors are the key to leadership in electronics.

o Competitive, high-volume production is the key to leadership in semiconductors.

o High-volume production is supported by the commercial market.

o Leadership in commercial volume production is being lost by the U.S. semiconductor industry.

o Semiconductor technology leadership, which in this field is closely coupled to manufacturing leadership, will soon reside abroad.

o Defense will soon depend on foreign sources for state-of-the-art technology in semiconductors.

Semiconductors, an *American* innovation that unlocked the door to the computer revolution, are extremely important to virtually all of today's high-technology weapon systems, but U.S. military purchases account for only a small percentage of world consumption, less than three percent of total sales. Although the American semiconductor industry was formerly the world leader in production and sales, foreign competition---especially from nations along the Pacific rim such as Japan, Korea, and Taiwan---has cut into this lead dramatically. Chart 23 shows the trend in market shares of the world merchant semiconductor market---as opposed to "captive production," which are semiconductors made specifically for internal consumption, belonging to the United States and Japan. In the critical Dynamic Random Access Memory (DRAM) field, the bellwether of mass production capability, the U.S. share has dropped from close to 100 percent in the mid-1970s to less than five percent of the non-captive market.[18]

One area where the United States retains its leadership is in the design of integrated circuits and the production of low-volume specialty chips. According to the DSB report, however, the key to leadership in semiconductor technology is in high-volume production of chips.[19]

The woes of the American semiconductor industry generally mirror those of other U.S. manufacturing industries: foreign competition for American and world market share; movement of U.S. firms offshore where labor and overhead costs are lower; protectionist policies of foreign governments; and the rising cost of high-technology research and manufacturing.

Several reasons have been identified as being specifically responsible for the lamentable state of the U.S. semiconductor industry. Most prominent is the argument that the Japanese government aids its domestic industry through the use of low-interest financing unavailable to U.S. firms.

Another is that the overall structure of the Japanese semiconductor industry also differs from that of the United States. Most Japanese semiconductor manufacturers are part of a larger industrial conglomerate, which means that they can afford to accept early losses, giving them time to establish a highly profitable market segment over a longer time frame. Smaller, independent U.S. companies must make a profit quickly in order to remain in business, while larger companies usually manufacture only for internal consumption.

A third area where U.S. and Japanese corporate structures differ is in the area of required profit. U.S. firms typically must make a higher profit on the same level of sales than a Japanese company, principally because of stockholder requirements and to compensate for the higher cost of capital in the United States. These dynamics have left U.S. firms struggling for market share in the face of competitors who could accept a lower level of profit and thus undersell them.

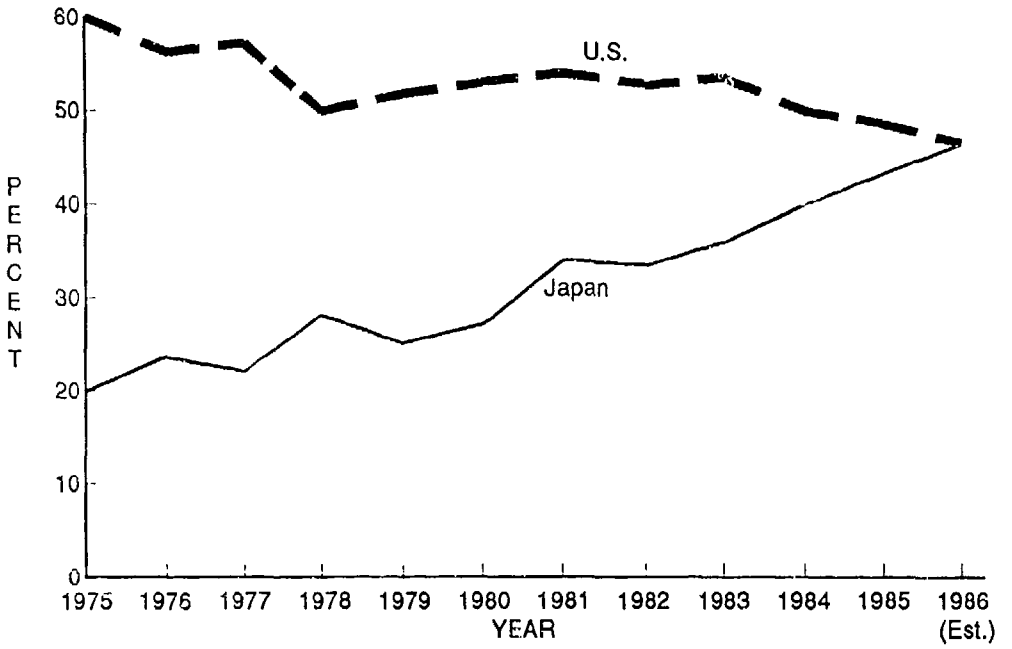
In response to industry pleas for help, the government in 1986 negotiated a trade agreement with Japan to stop the "dumping," or below-cost sale, of chips. This agreement has been credited by market analysts with propping up the price of memory chips on the open market, while causing a shortage of new high-capacity DRAMs. The only two remaining U.S. mass producers of DRAMs, Texas Instruments and Micron Technology, have both reported increased sales since the trade agreement was signed, but critics call the action a mistake and point to a mid-1988 rise in computer prices as the result of a chip shortage caused by the reduced competition.

While the wisdom of protectionist legislation may be debatable from an economic stand-

CHART 23

SHARE OF WORLDWIDE INTEGRATED CIRCUIT SHIPMENTS

(Merchant Producers)



Source: Defense Science Board, Report of the Defense Science Board Task Force on Semiconductor Dependency (Washington, D.C.: GPO, February 1987), p. 5.

point, from a national security perspective, the nation requires a healthy domestic semiconductor industry to support increasingly complex and sophisticated weapons.

In response to this perceived need, the Defense Science Board (DSB) in 1987 proposed five recommendations in order to help the United States semiconductor industry remain a major factor in the world market. According to the DSB's recommendations, the government should:

o Support the establishment of a Semiconductor Manufacturing Technology Institute (SEMATECH) that would develop, demonstrate, and advance the technology base for efficient, high-yield manufacture of advanced semiconductor devices and provide facilities for production of selected devices for Defense Department needs. Such an institute could have an important impact not only on Department of Defense but in the commercial market as well, when member firms transfer technology to their own applications. The initial capitalization of the Institute by its industrial members would be on the order of $250 million, and support of approximately $200 million per year for five years would be provided by the Department of Defense.

o Establish at eight universities Centers of Excellence for Semiconductor Science and Engineering built upon current National Science Foundation, Department of Defense, and commercial consortium programs, to devise, develop, and demonstrate new and innovative approaches to device design and manufacturing that lower costs and improve performance and quality. The estimated cost of this program to the Department of Defense would be about $50 million per year.

o Increase DoD spending for research and development in semiconductor materials, devices, and manufacturing infrastructure by about twenty-

five percent per year for four years. The cost of this increase will be $60 million in the first year, growing to $250 million in the fourth year.

o Provide a source of discretionary funds to the Defense Department's semiconductor suppliers to underpin a healthy industrial research and development program. The cost of this activity should be about $50 million per year and should be restricted to work directly related to semiconductor needs of the Department of Defense.

o Establish under the Department of Defense a unified government/industry/university forum for semiconductors in order to provide a common meeting ground for assessment of the overall program and to facilitate joint action on problems of semiconductor research, development, and production of specific interest to national defense. Cost of this recommendation to DoD should be about $200 million per year, principally for administrative costs.

Several of these recommendations have already been implemented, the most important of which, SEMATECH, has received strong congressional backing---despite a lack of enthusiasm within some sectors of DoD.

Precision Optics

The importance of precision optical devices to national security is, like the pharmaceutical industry, little noted and much ignored, but they are vital to equipment such as laser range finders for tanks, high-resolution photographic equipment for satellites, and many present and future needs of the Strategic Defense Initiative, among numerous other uses. According to testimony presented to Congress in March 1988 by Under Secretary of Defense (Acquisition) Costello, the U.S. precision optics industry would be able to provide only sixty percent of national mobilization requirements.[20] Costello also commented that "while there has been a significant decline in our industry's ability to compete in high-volume, low-cost commercial markets such as photographic lenses, many U.S. firms continue to participate in highly specialized, low-volume optics markets." In order to remain viable in this field, a strong R&D effort is critical. "Of particular interest," Costello noted, "are the development of machines and equipment to increase manufacturing productivity, development of more sophisticated coating technologies and research in aspheric lens production."

Costello's views were supported by a 1987 report of the Joint Precision Optical Technical Group (JPOTG), a DoD working group under the multiservice Joint Logistics Command.[21] The JPOTG study found that U.S. domestic production of precision optics had dropped substantially in the years preceding 1985 and fell even further in 1986, with industry operating at only sixty percent capacity in 1985 and falling by another twenty percent in 1986. U.S. sources for raw optical glass also continued to decline, with only one U.S. firm still in production. More than seventy percent of all domestic consumption of raw glass comes from foreign sources.

Foreign-made finished optical elements made up more than fifty percent of Department of Defense consumption in 1986 and ninety-eight percent of U.S. consumption as a whole, while employment in that sector fell from 3,096 jobs in 1981 to 1,655 in 1986. (See Chart 24 for a breakdown of sources for DoD optical component purchases.) Causes for the drop in U.S. production capacity are the lower prices of imported raw and finished glass products, the movement of U.S. firms offshore to cut costs, and, increasingly, the use of offsets by foreign nations. The JPOTG report cited two instances in which U.S. firms had lost contracts to Swiss and Canadian suppliers in the sale of air-to-ground and anti-tank missiles. Several subcontractors also complained that offsets had indirectly affected their sales by taking business away from the companies they supplied.[22]

In the event of a surge/mobilization situation, the JPOTG report identified several bottlenecks to increasing production in U.S. factories. Chief among these were: a lack of skilled labor, especially opticians; a shortage of raw materials if foreign sources were unavailable; and the difficulty in obtaining specialized tooling, most of which is manufactured overseas. When a JPOTG survey asked companies how long it would take them to reach full production capacity, the average figure given was forty-three weeks.

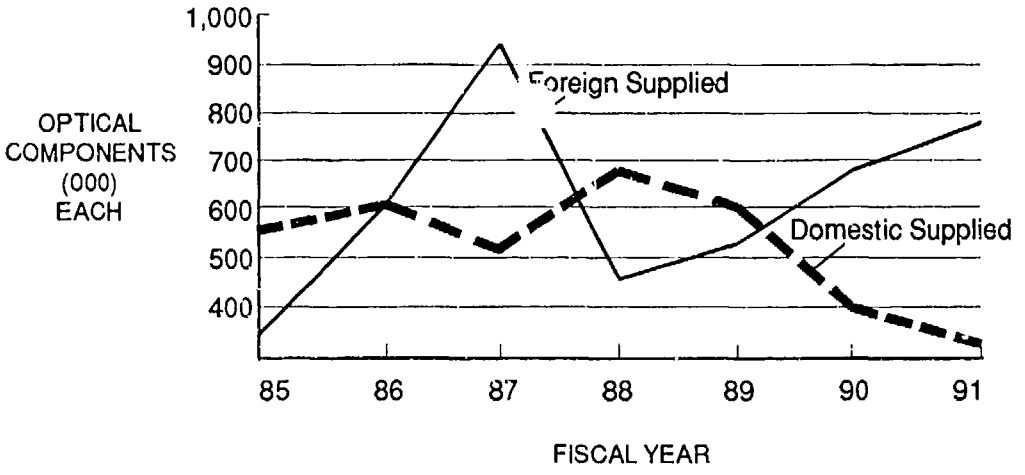
To correct these deficiencies in the vital domestic precision optics base, the technical group report made several recommendations:

o Establishment of a seven-year, temporary Federal Acquisition Regulation for all elements of the precision optical elements and optical glass industry, phased in over two years. Although this would increase the cost of precision optics, it would serve to protect and encourage a healthy domestic industry vital to the nation's security. The temporary nature of the regulation would encourage domestic industry to invest in new technology and capacity to increase efficiency and competitiveness before the statute expired.

o Preparation by the Department of Commerce of a report on the state of the world precision optics industry and an assessment of the fairness

CHART 24

DEPENDENCY IN OPTICAL COMPONENTS



Far East producers are now competing in the DoD market for peacetime purchases of optical supplies. The trend indicates that they will capture an increasing share of that market.

Source: Joint Precision Optics Technical Group, Final Report of the Joint Precision Optics Technical Group (Washington, D.C.: Joint Group on the Industrial Base, June 1987), p. 25.

and openness of world markets, which would make recommendations to increase levels of trade if protectionism and governmental subsidies are discovered.

Without some measure of assistance from the federal government, the precision optics industry in the United States faces an uncertain future. Without this important industry, the nation would be faced with yet another threat to its ability to defend itself and its allies adequately in time of crisis. While preserving this industry may increase costs in the near term, it will prove a valuable investment in a technology critical to the future viability of U.S. industry as a whole.

End Notes

[1] *Bolstering Defense Industrial Competitiveness, op.cit.*

[2] F. Clifton Berry, Jr., "Facts and Fallacies About Aerospace," *AIR FORCE Magazine*, February 1988.

[3] Paine Weber, Aerospace Industry, August 19, 1987, updated January 1988, cited in MAC Group, *op.cit.*

[4] White House Press Release, May 20, 1986.

[5] National Machine Tools Builders Association, *Economic Handbook of the Machine Tool Industry*, (McLean, Virginia, 1985).

[6] James H. Mack, testimony before the Senate Finance Committee, 99th Congress, 2nd Session, on S. 1871, *op.cit.*, August 13, 1986.

[7] National Machine Tool Builders Association data, 1988.

[8] See Scott C. Truver, "Sealift Manning: Critical Period, Critical Choices," *Armed Forces Journal International* (July 1987), p. 38.

[9] James D. Hessman and Vincent Thomas, Jr., "Disasters by the Year 2000: An Interview With Sen. Jeremiah Denton," *Sea Power* (May 1988), pp. 7-14.

[10] Committee on Merchant Marine and Fisheries News Release, House of Representatives, June 12, 1986. See also *America's Vanishing Merchant Mariners: Diagnosis, Prognosis and Prescriptions for a Strong National Defense* (Camp Springs, Maryland: Transportation Institute, September 1986), pp. 9-11.

[11] Commission on Merchant Marine and Defense, *Findings of Fact and Conclusions* (Washington, D.C.: GPO, September 30, 1987), p. 29.

[12] Testimony to the Senate Committee on Armed Services, Subcommittee on Projection Forces and

Regional Defense, April 12, 1988, mimeo.

[13] Commission on Merchant Marine and Defense, *op.cit.*

[14] Federal Emergency Management Agency, *Pharmaceutical Production Levels, Inventories, and Vulnerabilities* (Washington, D.C.: GPO, December 30, 1987), pp. 16-17.

[15] *Ibid.*, p. 68.

[16] Directorate of Medical Material, Defense Logistics Agency, "FY '86 Production Base Analysis," December 1986.

[17] Office of the Under Secretary of Defense for Acquisition, Defense Science Board, *Defense Semiconductor Dependency* (Washington, D.C.: GPO, February 1987), pp. 1-2.

[18] *Ibid.*, p. 5.

[19] *Ibid.*, p. 26.

[20] Robert C. Costello, testimory before the Senate Armed Services Committee, March 17, 1988, mimeo.

[21] Robert P. O'Shaughnessy, *et al.*, "Final Report of the Joint Precision Optics Technical Group," June 1987.

[22] *Ibid.*, p. 55.

6. Government Attempts to Cope

Even before World War II the government attempted to regulate the country's defense industries to conform them to its needs and wants, as well as to prepare for future mobilization needs.

Many measures intended to support and regulate the defense industrial base already exist, as do actions planned for implementation in the event of a national emergency. Principally, these are the Defense Production Act of 1950 and its amendments; various Major Emergency Action papers; and the several industrial modernization programs currently underway to help revitalize the defense industry.

Defense Production Act

Enacted on September 8, 1950, the Defense Production Act encompassed seven sections or titles, many of which have been repealed in the intervening years (Titles II, IV, V, and VI), while other parts have been substantially modified. In Title I of the Act, the President is given the authority to determine priorities and allocations. This enabled him to "require that performance under contracts or orders...which he deems necessary or appropriate to promote the national defense shall take priority over...any other contract or order...and to allocate materials and facilities in such manner...as he shall deem necessary or appropriate to promote the national defense." Over the years, this rather elastic title has been used to justify priorities for a broad range of things necessary for "national defense," including the space program and the Alaska oil pipeline, among others.

The heart of Title III, expansion of productive capacity and supply, was intended to provide authority for diverse incentives to industry to expand facilities and production, especially in the areas of raw materials exploration and development. These incentives were to be financed through funds borrowed from theTreasury, with a ceiling of $600 million that was later raised to $2.1 billion when the lower figure proved inadequate. In the six years following its 1950 enactment, Title III loans are credited with permitting the nation to double its output of copper and aluminum and establish a national titanium industry. The section on borrowing was phased out in 1974 and replaced with a stipulation that all future loans to industry would be as a result of specific budget appropriations. This effectively stripped Title III of much of its value, although it did leave in place the foundation for programs such as the machine tool trigger orders program discussed a bit later.

The final surviving title (VII) of the 1950 Act provides the basis for several important ongoing programs. One is the small business set-aside program that gives domestic small and minority businesses a portion of all defense contracts, up to five percent, valued at $300 billion in the Fiscal Year 1988 budget. The set-aside program has, however, been the subject of some scrutiny following charges of fraud and misleading business practices.

Another segment of Title VII provides for the establishment of a series of Voluntary and Standby Agreements between government and industry. A Standby Agreement is defined as a "contractual commitment by a private firm concerning specific goods and services to satisfy increased needs during and emergency." A Voluntary Agreement is an "association of companies granted antitrust relief under Section 708 of the Defense Production Act to engage in activities in support of national security needs."[1] Both agreements permit substantial preplanning of mobilization actions.

Benefits afforded by voluntary and standby agreements would:[2]

- Promote more effective conversion of new producers, help identify and resolve production bottlenecks, and help maximize production within limited capacity.

- Reduce the need for peacetime investments in standby production and test equipment by identifying changes in production or test specifications that could increase emergency output from current facilities.

- Provide an effective way to identify requirements for new production equipment or facilities in peacetime so that they could be available sooner in an emergency.

Last, Title VII allows the President to create new agencies necessary for mobilization, to issue regulations guiding defense planning, and to collect data on the state of the defense industrial base. This title, moreover, is the basis for the authority to carry out the numerous analytical studies of the produc-

tion base and establishing the guidelines governing surge/mobilization situations.

The Defense Production Act has been amended many times since it was enacted, but it remains the principal piece of legislation designed to enhance defense industrial preparedness. There are a number of points of view about how to go about pursuing that goal more effectively.

One is that the DPA is seriously flawed, and new legislation is required. As noted, there must be a specific appropriation for each loan made under Title III. Thus, even high priority actions to promote exploration and development of U.S. raw materials or expansion of defense industries can get lost in the morass of the congressional budget process.

Nor, these critics contend, is there an adequate infrastructure in Congress for oversight of the DPA or defense industrial base issues in general. Until 1977, DPA oversight was the function of the Joint Committee on Defense Production. The Joint Committee, established by the DPA, served as a focal point for these issues and as a policy and procedural "clearinghouse" for the many committees that have jurisdiction over legislation pertaining to the defense industrial base. When the Joint Committee was abolished, its functions were assigned to the House and Senate banking committees, on the bizarre theory that these committees could perform the same role more cheaply. The practical effect has been to dilute congressional authority in this area. Virtually every standing Senate committee and about fifteen House committees have jurisdiction over some aspect of the defense industrial base. To put DPA oversight in the banking committees, in which reside little defense expertise, curtails use of this legislation to enhance the defense industrial base. It can also be fairly noted that the Federal Emergency Management Agency (FEMA), the lead planning and coordinating agency for DPA activities, is hardly a bureaucratic powerhouse in the Washington scene. Without an effective voice in the Executive Branch, defense industrial base issues tend to lose budget battles. In the early 1980s, FEMA proposed dramatic increases in Title III loans. They never materialized.

Use of the DPA has focused on U.S. raw material production. Defense industrial base issues, however, now center on competitiveness, efficiency, and innovation in U.S. industry. Stockpiling, or alternatives thereto, are only part of the problem the nation now faces.

Another point of view is that the DPA provides adequate authority to protect and expand the defense industrial base, if only Congress and the Executive Branch would take advantage of it. The fact that Congress must approve specific appropriations for Title III incentives means simply that Congress must actually act on the growing sentiment that the U.S. defense industrial base is no longer adequate. One recommendation (proposed by former Air Force Systems Command Commander Gen. Alton Slay in 1980[3]) was to support domestic production of minerals, such as cobalt and titanium, essential to the production of modern weapons. Furthermore, while Title III has been used in the past primarily as a means to promote the U.S. mining industry, it also allows for incentives and loans for other industries to modernize and expand.

Finally, there are those who advocate amending the DPA. In the most recent hearings on reapproval held in the spring of 1988 before the House Banking, Finance, and Urban Affairs Subcommittee on Economic Stabilization, several significant modifications were recommended. Among the most important were proposals for substantial "Buy American" provisions, which would have required the President to limit procurement of defense equipment and requisite services to domestic firms until such time as the Secretary of Defense certifies that "domestic sources for such weapons and their systems, including all parts and components, can meet defense production needs for six months following any declaration of war...." The passage of this proposal was uncertain at the time of writing and, according to congressional insiders, becoming increasingly remote. If enacted, it would radically alter the manner in which the nation procures it weapons.

Weapons containing only domestic parts would drive costs up greatly. Businesses in many sectors would have a virtual monopoly on the manufacture of some items, driving up their price and leading to potential production delays if capacity were below demand. These delays could slow down the fielding of new-generation weapons and systems, weakening---rather than strengthening---America's military capability. In addition, it would infuriate U.S. allies by cancelling joint production ventures and depriving their defense industries of contracts. (A more mundane effect would likely be claims for contract termination fees that could run into "astronomically high figures," according to one DoD analyst.)

While much constricted from its original embodiment, the Defense Production Act still lays the foundation necessary to support the United States in any future surge/mobilization scenarios and authorizes the requisite peacetime infrastructure needed to implement emergency plans. Without the authorities provided by the 1950 Act, the requirement for the government to make broad-based contingency plans and provide for the surged/

mobilized industrial base would be utterly frustrated.

Major Emergency Action Papers

The Major Emergency Action (MEA) Papers are prewritten plans designed to cover various contingencies of any future mobilization. As described by the Federal Emergency Management Agency, they are: "intended for use in the option identification phase of the policy process, when the decision-maker's primary concern is to understand the problem and the range of options that are available. The action papers provide means to stimulate advance thinking about the substantive, political, and economic feasibility of alternative actions and set the stage for detailed interagency planning and decision making.... The papers are designed to provide a comprehensive inventory of available actions and supplement current planning documents and decision information support systems. They do not replace current mobilization plans."[4]

Chart 25 provides a list of the principal MEAs in existence as of June 1985, giving a general outline of the types of actions open to the President in the event of a national crisis. They thus allow the consideration of a measured response to a crisis situation and their use can signal U.S. determination and intent to hostile countries.

MEAs are prepared and maintained by various primary action agencies within the government, under whose jurisdiction the actions fall, including the Departments of Commerce, Defense, Energy, Interior, and Transportation; the Federal Emergency Management Agency; the Federal Trade Commission; and the General Services Agency. This overview of the defense industrial base is primarily concerned about those MEAs directly affecting industrial mobilization, the Industrial Production MEAs (IPMEAs), although many of the other areas affect the defense sector, albeit, indirectly.

Another DoD mobilization initiative similar to the MEAs, termed Industrial Mobilization Responsiveness, is just now in 1988 being instituted. Under this program, several "ready action packages" of options will be developed that can be selected to meet specific, if somewhat generalized, emergency situations. These packages provide planners a full range of responses, from maintenance of the status quo to full-scale mobilization, indexed by international warning signals given by potential adversaries.

Industrial MEAs are split into three categories: (1) those governing surge production situations; (2) those dealing with the expansion of defense production; and (3) full industrial mobilization. Actions from the surge production category are:[5]

o *IP-1. Expand and Enforce Priorities and Allocations System.* This action modifies the Defense Priorities and Allocations System (DPAS), which is the peacetime mechanism to keep military acquisition programs on schedule. In an emergency, the government could increase training and enforcement of DPAS regulations; increase the number and quantities of materials controlled by the DPAS; or broaden the priorities and allocations systems to cover important allied and/or civilian production. Key agencies for this action are DoC, DoD, DoE, and FEMA.

o *IP-2. Release Materials from the National Defense Stockpile.* Stockpiled materials can provide an immediate means of mitigating material constraints in defense production. When an emergency occurs, the government can release part or all of a stocked substance for use in defense production.

Industrial MEAs covering expanded production are intended to meet requirements for additional workers, tools, and test equipment and will build upon actions taken in any previous surge scenario. These actions include:[6]

o *IP-3. Provide Financial Incentives for the Expansion of Productive Capacity and Supply.* This action expands the government's program for providing loans, loan guarantees, and purchase guarantees to industry as incentives to facilitate surge, develop new sources of raw materials, and to expand defense production capacity. Since incentives are provided on a limited scale during peacetime, this emergency action primarily involves increasing the number and value of projects funded and undertaking riskier investments. Responsible agencies for this action are DoD, DoC, DoI, USDA, DoT, and FEMA.

o *IP-4. Active Voluntary Agreements with Industry.* Under this action, the government could call together representatives of industry to jointly solve industry-wide production or supply problems caused by defense expansion. Legislation provides participants with antitrust protection, since some voluntary agreement activities may have an anticompetitive effect. Several departments can recommend agreements. Approval authority rest with FEMA, DoJ, and FTC.

o *IP-5. Activate Machine Tool Trigger Orders.* Machine tools have been a production bottleneck in past wars. If machine tools are not

CHART 25

MAJOR EMERGENCY ACTION PAPERS (JUNE 1985)

FUNCTIONAL AREA	MEA PAPER
Communications	- Augment Federal Systems - Limit Unessential Traffic
Domestic Economics	- Credit Controls - Consumer Rationing - Price, Wage, Salary and Rent Controls
Energy	- Strategic Petroleum Reserve Drawdown - Surge Naval Petroleum Reserve Production - Waive Regulations - Facilitate Fuel Substitution - Implement Energy Priorities - Implement Oil Sharing
Government Preparedness	- Activate NDER - Declare National Emergency - Implement Emergency Staffing - Convert to Emergency Structures
Health	- Activate National Disaster Medical System - Hiring PHS Commissioned Corps Under Military Justice Code
Human Resources	- Resolve Labor Management Disputes - Provide Incentives to Labor Force Priorities
Industrial Production	- Priorities and Allocations - Release from Stockpile - Financial Incentives - Voluntary Agreements - Machine Tool Trigger Orders - Distribution of Production Resources - Inventory Controls - Limit Use of Scarce Materials and Facilities - Relief from Regulatory Requirements
International Economics	- Import Controls - Export Controls - Financial and Economic Sanctions
Social Services and Housing	- Activate Non-Combatant Evacuation - Provide Repatriation Assistance - Rebuild Housing in Post-Attack - Provide Temporary Housing in Post-Attack - Provide Housing in Crisis Relocation
Transportation	- CRAF Activation - WASP Implementation - NDRF Activation - Priorities and Allocation of Surface Transportation

Source: FEMA, Overview of the Major Emergency Action Papers and Industrial Production (Washington, D.C.: GPO, July 1985), p. 1.

ordered quickly in a future emergency, tool lead-times could slow the expansion of defense production. The government has, therefore, developed standby contracts with machine tool producers and will purchase all tools that cannot be sold to defense contractors. This emergency plan calls for the execution of some or all of the (prearranged) agreements. Responsible agencies are DoD, DoC, FEMA, and GSA.

o *IP-6. Control the Distribution of Production Resources in the Civilian Market.* Defense priority ratings give producers of defense items first claim on production facilities and materials. A significant growth in defense production could severely curtail the resources available to produce nondefense items. This major emergency action allows the government to allocate remaining resources to essential civilian production.

Industrial mobilization in essence involves all actions that transform the nation's economy into an engine focused on a single goal, that of greatly increased military production. This means that the changes instituted are dramatic and far-reaching and that the MEAs have an extremely broad impact on the overall economy. Actions in this group are:[7]

o *IP-7. Institute Inventory Controls.* This action would be taken in the event of an extreme supply shortage. The government would break up the excess inventories held by individual producers and prevent further hoarding by limiting the amount of material that can be ordered and delivered. Inventory controls were widely used during World War II. Lead agencies are DoC and FEMA.

o *IP-8. Impose Limitations on the use of Scarce Materials and Production Facilities.* In a major mobilization, it may become necessary to curtail or stop the production of certain consumer items to free additional manpower, resources, and facilities for use in the defense sector. This action calls for the encouragement of voluntary restraints on the part of civil producers or, in more extreme cases, the issuance of directives prohibiting the use of scarce resources or production facilities for nonessential items. The lead agencies for this action are DoC and FEMA.

o *IP-9. Obtain Relief from Statutory and Regulatory Requirements that Inhibit Production.* In a major emergency, the need to rapidly mobilize for defense production could temporarily take precedence over ongoing programs to protect the environment, ensure worker safety, or distribute contracts in an equitable or cost-effective manner. The government could take emergency actions to modify or waive standards/regulations in selected cases in the interest of national defense. DoD or DoC would take the lead in recommending waivers and regulatory agencies would provide decision-making input.

It is important to note that the President does not have the standing authority to implement all of these actions. Doing so would require close consultation with Congress to obtain the necessary legislation and careful interagency planning to carry out the plans. The MEAs themselves grant no authority---they merely aid planners and decision-makers in choosing a course of action.

Government-Sponsored Modernization

As part of its efforts to help U.S. industry regain its competitive edge, several government-sponsored initiatives have been created to aid domestic firms in modernizing their factories, increasing productivity and efficiency, and developing new technologies and applications. Funding and oversight for these actions are contained in several DoD programs, principally the Industrial Modernization Incentives Program (IMIP), the Manufacturing Technology program (ManTech), and the SEMATECH (for Semiconductor Manufacturing Technology) program.

IMIP is intended to provide an incentive for defense contractors to make capital investments to "enhance productivity, improve quality, reduce acquisition costs, and expand the industrial base," while keeping direct investment by the government to a minimum.[8] This is accomplished by returning a part of the savings obtained through reductions in production costs, resulting from the increases in efficiency and quality, by DoD to the contractor. The amount of the return is based on the savings necessary to achieve a fair return on investment. IMIP is typically used in projects considered too financially or technically risky to be undertaken in the course of normal business.

Since the program's inception in 1982, when the Air Force Technology Modernization (TECH MOD) program and Army Industrial Productivity Initiatives were consolidated, more than $500 million has been invested by the government and $1.7 billion by the 200 active DoD prime contractors and subcontractors participating in IMIP. The result has been a savings of $630 million through mid-1988, with a projected savings by government of more than $1.9 billion by 1992.[9]

The example below illustrates the procedure used when a contractor decides to participate in an Air Force IMIP. Participation in the program involves a three-stage process outlined in the Air Force's Industrial Base Program Handbook:[10]

o *Phase I* is a top down, factory-wide analysis of manufacturing and support operations identifying modernization opportunities. The key element of an IMIP is the business agreement. Negotiated prior to funding in Phase II, the business agreement establishes a mechanism for computing and providing incentives to the contractor and benefits to the Air Force.

o *Phase II* is a design phase that consists of developing specific project plans to achieve factory modernization. It identifies implementation schedules, specific hardware and software requirements, and validates specific applications through demonstrations, prototypes, etc.

o *Phase III* implements Phase II projects that meet the contractor's required return on investment. Implementation includes contractor purchasing of capital equipment, installing new technologies, and/or improving management procedures.

Air Force IMIPs are further divided into two categories known as Modernization Investment Projects (MIPs) and Modernization Efficiency Projects (MEPs). On the one hand, a MIP involves contractor investment in capital equipment above that minimum necessary to support immediate production needs, thereby making increases in capacity possible in the event of a surge/mobilization. On the other hand, MEPs require no capital investment, but rather involve plant rearrangement, reductions in overhead, or establishing management information systems to achieve productivity increases.

Successful examples of IMIP programs include Northrop's Integrated Management, Planning, and Control for Assembly (IMPCA), reported to have saved the company some $24 million on its F/A-18 Hornet fighter, and Lockheed's Extrusion Trim Center (ETC), which controls the flow of small, extruded aluminum parts during fabrication. ETC was actually developed under TECH MOD, the forerunner program to IMIP.

A companion program to IMIP, ManTech has similar goals but focuses on technology research projects designed to develop new types of manufacturing technology, whereas IMIP's goal is to place previously developed technologies into factories. In March 1988, Under Secretary for Defense (Acquisition) Costello in testimony before the Senate Committee on Small Business, Subcommittee on Innovation, Technology, and Productivity said that ManTech is "...the principal focus for developing manufacturing technology." He further described the program by saying that "ManTech steps in when the private sector is either unable or unwilling to meet DoD's requirements," and "...develops first case, factory floor applications of advanced technology."[11]

Another goal of ManTech is to increase domestic technology transfer through end-of-contract briefings to other manufacturers. Additionally, ManTech reports are available through the Defense Technical Information Center, and the Manufacturing Technology Information Analysis Center maintains a database of this material. It also recently compiled an eleven-volume index of all DoD-sponsored research done over the last decade that might be of interest to machine tool manufacturers.

A typical ManTech program is broken down into five stages:[12] *Basic Research* to formulate hypotheses; *Applied Research* to conduct experiments and test these hypotheses; *Advanced Development* to establish a repeatable process; *Engineering Development* to develop a prototype/model manufacturing process; and *Production Implementation* to install the newly developed process in a manufacturing or repair facility.

The program's track record is an impressive seventy percent success ratio, with more than 100 projects currently funded. The government estimates that the rate of return on ManTech projects is 14:1. Fiscal Year 1988 ManTech funding was pegged at $156 million ($11 million less than requested), and $172 million was requested for fiscal 1989. At present, ManTech is focusing on Computer Integrated Manufacturing, machine tools, and the Manufacturing Science (ManScience) efforts investigating the application of artificial intelligence to manufacturing to develop the "factory of the future."

One consistent problem with both IMIP and ManTech has been a lack of enthusiasm for the programs. General Marsh, while praising the programs and their goals, cited a "lack of tri-service support and consequent lack of funding" for both. He called for DoD to provide "strategic direction and priorities based on top-level...planning."[13]

SEMATECH

The recent and continuing dramatic drop in the United States' leadership in world semiconductor technology, depicted in Chart 26, shocked many leaders in government and industry into taking a hard look at the nation's semiconductor industry. What they found left them appalled. By 1986, only two U.S. manufacturers of merchant (commercially available) semiconductors remained in business (Micron Technologies and Texas Industries), and both were on uncertain financial ground. While the nation still led the world in specialty chips and circuit boards, its edge was rapidly eroding as well.

CHART 26

THE SHIFT IN SEMICONDUCTOR TECHNOLOGY

	JAPAN LEAD	U.S.-JAPAN PARITY	U.S. LEAD
Silicon Products			
DRAMs	▼		
SRAMs	▼		
EPROMs		⬬	
Microprocessors			▼
Custom, Semicustom Logic			▼
Bipolar	▼		
Nonsilicon Products			
Memory	▼		
Logic	▼		
Linear			⬬
Optoelectronics	▼		
Heterostructures	▼		
Materials			
Silicon	▼		
Gallium Arsenide	▼		
Processing Equipment			
Optical Lithography		▼	
E-beam Lithography			
X-ray Lithography		▼	▼
Ion Implantation Technology			
Chemical Vapor Deposition		⬬	▼
Deposition, Diffusion, Other		⬬	
Energy-Assisted Processing	▼		
Assembly		⬬	
Packaging	▼		
Test	▼		
CAE		⬬	
CAM		▼	

▲ U.S. Position Improving
⬬ U.S. Position Maintaining
▼ U.S. Position Declining

Source: Defense Science Board, Report of the Defense Science Board Task Force on Semiconductor Dependency (Washington, D.C.: Office of the Under Secretary of Defense for Acquisition, February 1987), p. 58.

Much of the blame for this loss of U.S. leadership has been placed on the support given foreign, especially Japanese, companies by their governments. In Japan, the Ministry of International Trade and Industry (MITI) and Nippon Telephone and Telegraph (NT&T), a government entity, both participate in joint programs with industry to develop advanced technologies and, sometimes, specific products. It was such joint programs that allowed Japanese companies to capture much of the world market in 64K DRAM chips, then the world standard in computer memory, in the early to mid-1980s. Similar joint ventures are now under way to develop technological superiority in optoelectronics (optical semiconductors) and supercomputers. (Chart 27 provides a listing of foreign joint projects in microelectronics.)

Based on the recommendations of a 1986 Defense Science Board Summer Study of the U.S. semiconductor industry, the Congress and Department of Defense, in conjunction with industry, created the Semiconductor Manufacturing Technology (SEMATECH) initiative in order to combat foreign government/industry joint ventures. Founded on May 12, 1987, by fourteen computer and electronics manufacturers, SEMATECH's "goal is to ensure the U.S. of a world-leading manufacturing capability with exclusively domestic content by 1993."[14] To accomplish this goal SEMATECH is to be jointly funded by government and industry; its $250 million annual budget is divided equally between the two parties, with the federal government appropriating $100 million in Fiscal Year 1988 as its share to establish the program. (The initial pro-

posal had been that government fund the program at $200 million per year for five years.) Headquarters for the new organization is at the University of Texas' Montopolis Research Center in Austin, Texas, where SEMATECH will occupy a 300,000-square-foot facility.

SEMATECH's two primary goals are to:[15]

o Implement programs to develop and demonstrate advanced semiconductor manufacturing techniques. Improvements will be in equipment, materials, processes, manufacturing systems, and procedures.

o Demonstrate cost-effective manufacturing capability on competitive leading-edge manufacturing demonstration vehicles with preferential availability of all equipment, systems, materials, supplies, and chemicals to the members.

SEMATECH is structured much like a manufacturing company, with a board of directors comprising representatives of the companies investing in the project. One problem encountered early in the project was the absence of a chief executive officer. Despite an industry-wide search for a CEO, no major figures from the electronics industry were willing to step forward, perhaps fearing damage to their career should SEMATECH prove a failure. However, on July 27, 1988, Dr. Robert N. Noyce was named chief executive officer and Paul P. Castrucci was appointed chief operating officer.

Corporate tactics for the organization include:[16]

o Strategic planning workshops to generate road maps for each process, equipment, system, material, vehicle, and the like.

o A SEMATECH operating plan based on road maps to provide strategic planning to the members and the vendor base.

o Developing and demonstrating manufacturability of each unit process, core equipment module, and manufacturing system on a continuous progression of appropriate manufacturing demonstration vehicles.

o Utilizing U.S. suppliers of equipment and materials.

o Providing for the support and coordination of research activity to complement SEMATECH's development efforts. Research will be conducted in universities, government/national laboratories, and other research organizations.

The Manufacturing Demonstration Vehicles (MDV) are SEMATECH's principal means of developing new manufacturing technologies and processes. The first test chips, a sixty-four kilobyte Static Random Access Memory (SRAM) chip and a four megabyte DRAM chip, donated to be prototype MDVs were developed by AT&T and IBM, respectively, in their own research laboratories. These MDVs will serve as test products to be used in developing and testing a flexible manufacturing production line able to meet low-, medium-, and high-volume production needs and allowing the making of custom- and semicustom-made products.

SEMATECH will also support several university Centers of Excellence (COE) that will develop other new technologies and processes. The first five COEs and their projects were announced in May 1988: the University of Arizona, for contamination/defect control; the University of California at Berkeley, for optical lithography; a consortium of New Jersey Universities, for plasma etching; the University of New Mexico, for metrology; and the Massachusetts Microelectronics Center, for single wafer processing. The grants ranged from $500,000 to $1.5 million.

For all of its potential, however, SEMATECH is not without risks. The uniqueness of such a joint venture between government and industry in itself generated a great deal of controversy. A 1987 Congressional Budget Office study of the SEMATECH plan identified several possible negative features of and uncertainties about the project:[17] Whether SEMATECH's results would be disseminated to the best national advantage; whether SEMATECH's consortium design would become a precursor to a collusive arrangement; whether SEMATECH would unduly centralize the nation's research agenda in semiconductors; and whether both private and public participants can succeed in the new institutional roles imagined for them in the SEMATECH proposal.

While strong cases can be made both for and against these arguments, SEMATECH has become a reality, with almost certain congressional support for its first two years. It now only remains for the government to ensure that these potential problems never materialize, while at the same time not "regulating SEMATECH into the ground," as industry fears may happen.

Summary

Although the governmental programs outlined here do address many of the nation's high-technology needs, they fall far short of answering the requirements of the U.S. defense industrial base. These programs fail to address large segments of the industry (particularly the lower tier

CHART 27

JAPAN'S JOINT R&D

Country	Project	Companies	Technical Focus	Time Frame	Government Funds ($Millions)
Japan	MITI VLSI	5	VLSI Manufacturing	1975--79	$ 112
Japan	NTT VLSI	3	VLSI Device	1975--79	$ 309
Japan	New Function Elements	12	VLSI Device & Mfg.	1981--90	$ 140
Japan	Supercomputer	6	High Speed Devices	1981--89	$ 135
Japan	Optoelectronics	13	Optical Semiconductors	1979--86	$ 80
Japan	Sortec	13	Synchotron Lithography	1986--96	$ 62*
Japan	Optical ICs	13	Optical Semiconductors	1986--96	$ 42*
Korea	ETRI 4M DRAM	4	Develop 4M DRAM	N/A	$ 80
EEC	ESPRIT	Many	Commercial Computing	1984--94	$ 675
Britain	Alvey Project		Commercial Computing	1983--87	
Germany-Netherlands	Mega Project	2	1M SRAM/4M DRAM	1984--89	$ 150

Foreign government-supported joint R&D programs in commercial microelectronics.

* Funding from Key Technology Center includes some private contributions.

SEMATECH press release: Foreign Government Support of Joint Research and Development in Microelectronics (part of SEMATECH press kit, no date).

subcontractors) and are inadequately funded to be spread broadly across those sectors that they do cover. Thus their impact, while valuable, is not broad-based. Most observers agree that DoD is not, in and of itself, capable of completely supporting a domestic defense industrial base capable of meeting its full mobilization needs in peacetime.

While the problem itself remains ill-defined, General Marsh perhaps summarized the current situation best: "Given current information, I could not support a policy, as some propose, that requires a totally independent domestic defense production capability---I simply have no feel of the resource implications of such a policy, but I suspect that it would be prohibitively expensive." General Marsh also offered several alternatives that should be considered, including the establishment of domestic sources, stockpiling reserves, establishing backup inactive production capability, and maintaining a backup nondependent design. Many of these programs are already in existence or are being closely studied, but more time, effort, and federal funds will perforce need to be expended before these initiatives even come close to meeting the nation's surge and mobilization requirements.

Indeed, the Defense Department's own analysis of the industrial base comes to a similar conclusion and identifies "six strategic thrusts" that will be necessary to "maximize industry's potential": (1) forging better relations with industry; (2) improving the acquisition system; (3) establishing defense industrial strategic plans that support U.S. military strategic plans; (4) developing manufacturing capabilities concurrently with the development of weapon systems; (5) laying the foundation now for the technical skill base required for tomorrow's defense needs; and (6) ensuring that industrial base issues important to U.S. defense requirements benefit from the full spectrum of potential policy remedies.[18]

End Notes

[1] FEMA, *Affordable Strategies to Improve Industrial Responsiveness* (Washington, D.C.: GPO, January 1987), p. ES-1.
[2] *Ibid.*, p. ES-3.
[3] Gen. Alton D. Slay, testimony to the Industrial Preparedness panel, House Armed Services Committee, November 13, 1980.
[4] FEMA, *Overview of the Major Emergency Action Papers and Industrial Production* (Washington, D.C.: GPO, July 1985), p. 1.
[5] *Ibid.*, p. 3.
[6] *Ibid.*, p. 4.
[7] *Ibid.*, pp. 4-5.
[8] *Report of the Secretary of Defense Frank C. Carlucci to the Congress on the Amended FY 1988/FY 1989 Budget* (Washington, D.C.: GPO, February 18, 1988), p. 174.
[9] Aerospace Industries Association data, 1988.
[10] U.S. Air Force, "The Air Force Industrial Base Program," April 1987, p. 10.
[11] Robert Costello, Under Secretary of Defense, (Acquisition), testimony before the Senate Committee on Small Business, Subcommittee on Innovation, Technology, and Productivity, March 1, 1988, mimeo.
[12] U.S. Air Force, "The Air Force Industrial Base Program," *op.cit.*, p. 8.
[13] Gen. Robert T. Marsh, USAF (Ret.), testimony before the Subcommittee on Defense Industry and Technology of the Senate Armed Services Committee, March 30, 1988, mimeo.
[14] SEMATECH Press Kit Paper: "Meeting America's Technology Challenge," 1988, p. 2.
[15] *Ibid.*, p. 5.
[16] *Ibid.*, pp. 6-7.
[17] Congressional Budget Office, *The Benefits and Risks of Federal Funding for SEMATECH* (Washington, D.C.: GPO, September 1987), p. 46.
[18] *Bolstering Defense Industrial Competitiveness* (Washington, D.C.: DoD, July 1988), pp. vii, 39-62.

7. Conclusions and Recommendations

Conclusions

o *It would be a mistake for the United States to seek complete independence for its defense industrial base.* For many reasons, led by financial ones, this is impossible. This nation does not envision a single-handed defense of either the European or Pacific theaters of operation. In any such conflict, it is committed to fighting alongside its allies. A reasonable degree of interdependence and interoperability is logical under those circumstances.

At the same time, it would be foolish in the extreme for the United States to ignore critical vulnerabilities and foreign dependencies. Advanced semiconductors, pervasively used and pivotal in weapons quality, are an example of such a dependency. It would be irresponsible to rely on uncertain sources offshore for such items.

o *Government, industry, and labor all share in the blame for the raging "adversarial relationship" that exists, but the greater degree of fault is the government's.* The weight of evidence in deterioration of the relationship points to a massive tangle of laws and regulations, often in conflict with each other, and a poorly structured set of incentives and disincentives held out to defense contractors.

o *The problem transcends the Department of Defense and the defense industry.* Congress and various other federal agencies also influence the defense industrial base directly. In addition, the distinction between military products and commercial products is diminishing. No solution confined to the Department of Defense and the firms traditionally thought of as "defense industry" could encompass the whole problem. Such solutions, therefore, would be doomed to fail.

o *Without stability in the defense acquisition and budgeting processes, no real solution is possible.* Instability is a main root of the entire problem.

o *Any solution that works will be expensive.*

o *The Defense Industrial Base is not just the prime contractors.* It also includes suppliers and subcontractors, who have been forgotten or ignored too often in the past. Increasingly, the United States must think of commercial vendors as part of the defense industrial base, too. Such diverse groups as researchers in academia and those who mine critical minerals are important as well.

o *Producibility is crucial.* It is not enough to invent good ideas. Technological leadership also demands the ability to manufacture quality products at a competitive cost. It is in the nation's vital interest to promote this capability and to encourage the capital investments that put it into action.

o *The nation needs an "attitude check."* The United States should approach the problem with humility but not be abject about it. We can and should learn from other nations but should not always assume that the best answers inevitably lie abroad. We aren't the underdog yet, although our relative advantage is declining. The defense systems that set the standard for the world are American systems.

The nation should also stop viewing the defense industry with distaste and reexamine its fantasies about a "military-industrial complex." As this study and others show, no such thing exists. If it did, there would be no reason for this study.

o *American industry deserves better support than it has been getting from American government.* It's an open question whether the United States is ready for a Japanese-style Ministry of International Trade and Industry, or even a British-style Defence Export Services Organization. Clearly, though, the U.S. government could do more than it does---and it should do more.

Recommendations

1. A Presidential Commission---on the order of the Packard and Scowcroft Commissions---should be appointed to chart a course. This approach has been effective in helping the nation plan for defense management reform and strategic modernization. It is difficult to think of another kind of body that could serve better in the case of the defense industrial base.

2. The Department of Defense should begin now, before the Commission starts its work, to gather crucial information that does not presently exist. It must identify, all the way

to the end of the supplier and subcontractor chain the foreign dependencies involved for critical weapons and components. Thereafter, it must continue to monitor and report such dependencies. It must also discover the overlaps for sources, foreign and domestic, in surge production requirements for those critical weapons and components. This will be a major task and an expensive one, but until it is done, the nation is planning in the dark.

3. The Commission should (a) reexamine the field of incentives and disincentives in defense production and (b) plan reform of the tangled network of laws and regulations that have led us to the current condition.

4. Avoid hasty legislation. Legislative proposals abound, and advocates are urging Congress to attend in law to all manner of grievances. We urge Congress to legislate with economy, and in all cases, to consider the impact of the laws it makes. It was hasty, ad hoc legislation that created the tangle that the Commission would address as one of the priority problems.

5. The Department of Defense should adopt a more objective stance in its dealings with the defense industry. Fraud is intolerable, but willful misconduct or criminal wrongdoing are not characteristic of defense procurements or the defense industry as a whole. The Department of Defense says that it places a high priority on forging better relations with industry. One step toward achieving that goal would be to eliminate the arrogance with which it has too often approached industry in the past few years.

6. Prime contractors should nurture the supplier-contractor base. There have been various attempts, with various degrees of success, to rally prime contractors to the cause of restoring the supplier-subcontractor base. For reasons that this report makes obvious, the prime contractors should adopt this as a major initiative.

The defense industry should also shed the "bunker mentality" that it has adopted as a result of the repeated assaults made on it in recent years. It has a strong case to make on its own behalf and an important perspective that the nation needs to hear. That story will not be told if industry retreats into the bunker.

7. The federal government should conduct a major command post exercise (CPX) to diagnose and demonstrate the state of the defense industrial base. In 1978, a CPX called "Nifty Nugget" tested the nation's ability to mobilize, deploy, and support the armed forces in a major conflict. The results were disastrous. In the simulation, 400,000 troops were lost when ammunition and supplies did not arrive. Military Airlift Command received validated requests to move the same unit to twenty-seven different places. But "Nifty Nugget" revealed the problem in convincing detail, and it finally gave the nation a basis on which to rebuild its military mobilization plans.

A similar CPX involving the defense industrial base could do the same for the present problem. Such an exercise would, of course, require a formidable amount of preparation. If it is conducted in the near future, the results will be shocking. It would, however, provide credible answers to some important questions, and it would be a most useful step in the long road back to defense industrial preparedness.

APPENDIX

A Survey of the Industrial Associates of the Air Force Association

(As part of this assessment, the Air Force Association conducted a survey of its Industrial Associates. Forty-two of them responded, with some firms electing a corporate reply on behalf of divisions that are individually-enrolled associates. Since all Industrial Associates did not respond, however, the following is not presented as statistically representative of the entire list.)

Firms responding to this survey confirmed the view that defense contractors are looking to the future with trepidation and a certain hesitancy. Most indicated that changes to the acquisition process in the 1980s, requiring more contractor risk and investment while curtailing reimbursement, had been damaging to their profitability. Few expressed any confidence in recent proposals by government---including the highly touted "Could Cost" approach favored by Under Secretary of Defense (Acquisition) Robert Costello.

In regard to the issue of profitability, several firms in the software development business pointed to a special problem relating to their industry, citing the September 1987 Defense Science Board Task Force's report on Military Software, which stated that "building custom software for DoD has a poor profit margin. In calculating proper profit levels for cost-plus-incentive contracts, DoD tends to use the same margins for software development as for hardware development, although the latter is customarily followed by a production cycle at acceptable profit levels. Ten percent profit on sales is considered high in DoD, whereas it is grossly unacceptable in computer industry pricing on software."

Foreign penetration of U.S. markets was also confirmed, with companies that use foreign suppliers outnumbering those that do not by a 2:1 margin. A majority of firms responding, however, indicated that they had some form of contingency plan for dealing with a loss of current suppliers. Nevertheless, a substantial number of firms reported having at least one "single source" component---that is, one for which there is only one supplier.

A majority of respondents said that their foreign sales have been affected by offsets, and many reported purchasing materials from overseas as a direct result of offset agreements. Still, these companies believed, by more than a 2:1 margin, that they were competitive in foreign markets, with sixty-seven percent reporting that their foreign sales had increased during the last five to ten years.

Most companies reported the ability to surge production, assuming needed critical materials and components were available, but expressed concern about adequate supplies of skilled labor being available in that contingency. Among all respondents, the average time to double current production was eighteen months. Although a majority of companies reported needing only a year to do so, several major contractors stated that they would require up to forty-eight months. Few reported being aware of plans under consideration to develop "mobilization" versions of current weapon systems that would require fewer and less durable components than weapons built to last twenty years in peacetime. But a plurality doubted that their products would be compatible with such plans in any case.

On the issue of profitability, an overwhelming majority (ninety-eight percent) reported that their profitability had been affected by changes in tax laws and procurement regulations and that these changes had been unfair to defense contractors as a whole. A 2:1 majority also indicated that these changes have had a negative impact on their decisions to bid on some government contracts. In addition, ninety-five percent reported stretchouts in their defense related programs, which had a negative impact on the financial situation of both them and their subcontractors.

In the areas of new and innovative manufacturing technologies, a substantial majority of firms indicated that they had invested heavily in new technology in recent years. More than half said that they had taken part in at least one of the government's manufacturing technology initiatives, and most felt that these programs had the potential to benefit their specific industrial sector.

Response to the Survey

Numbers appearing beside each answer indicate the number of companies selecting that response. (DNR = did not respond or answer not applicable.)

What were your defense-related sales for the most recent fiscal year?

<$50 million = 10	$101--500 million = 11	>$1 billion = 8
$50--100 million = 7	$501 million--1 billion = 4	DNR = 2

Total sales of respondents = $45,645,376,259 Average sales per company = $1,141,134,406

How many employees does your company employ in its defense-related work?

<100 = 2	501--1,000 = 5	>5,000 = 10
100--500 = 7	1,001--5,000 = 16	DNR = 2

Average number of employees per company = 11,443

Subcontractor Base

How many subcontractors/vendors do you buy your major subcomponents from?

1--50 = 7	201--300 = 1	1,001--5,000 = 3
51--100 = 5	301--400 = 1	5,001--10,000 = 3
101--150 = 4	401--500 = 1	DNR = 12
151--200 = 4	501--1,000 = 1	

Total subcontractors = 39,941 Average per company = 1,331

Has the number of U.S. firms able to manufacture component parts related to your needs *decreased, increased,* or remained *stable* in the past ten years?

Decreased = 14 Increased = 6 Stable = 15 DNR = 7

Has this decrease/increase *accelerated, decelerated,* or remained *steady* over the last two to three years?

Accelerated = 8 Increased = 0 Decelerated = 17 DNR = 17

Are any of your subcomponent sources foreign firms?

Yes = 22 No = 11 DNR = 9

Would you say that *all, most,* or *some* of your suppliers are foreign?

All = 0 Most = 1 Some = 22 DNR = 19

If your subcontractors are overseas, do you anticipate being able to count on deliveries during a time of war or national emergency?

Yes = 10 No = 14 DNR = 18

Do you have any plans to make good the production shortfalls created by the loss of overseas suppliers through alternative sources?

Yes = 18 No = 14 DNR = 18

Is your company dependent on a single source for any key components or materials?

Yes = 12 No = 19 DNR = 11

Do you have a contingency plan in the event that this source goes off-line?

Yes =14 No = 10 DNR = 18

Do you know if any of your subcontractors/vendors are oversubscribed in the event of mobilization?

Yes = 10 No = 21 DNR = 11

Have you considered alternative sources or technologies to prevent bottlenecks in the event they are?

Yes = 16 No = 14 DNR = 12

Foreign Sales/Offset Agreements

Have any of your foreign sales been subject to offset agreements?

Yes = 20 No = 13 DNR = 9

Are any of your purchases of component parts from overseas the result of offset agreements?

Yes = 14 No = 18 DNR = 0

Are your foreign sales *higher* than, *lower* than, or the *same* as they were five to ten years ago?

Higher = 22 Lower = 5 Same = 6 DNR = 9

Do you believe that you are competitive in foreign markets?

Yes = 24 No = 11 DNR = 7

Have foreign nation trade restrictions hurt your sales in recent years?

Yes = 17 No = 16 DNR = 9

Do you believe that your industry has been targeted by unfair competition from foreign governments/industry?

Yes = 18 No = 15 DNR = 9

Mobilization

Do you have a production surge capacity for your principal product line(s)?

Yes = 24 No = 7 DNR = 11

Are you producing at or near capacity on these line(s)?

Yes = 6 No = 23 DNR = 12

Do many of your products contain critical materials likely to be unavailable/scarce during a future war/emergency?

Yes = 22 No = 10 DNR = 10

Do you have plans to deal with these scarcities through the use of alternative materials or technologies?

Yes = 11 No = 15 DNR = 16

Will manpower be a critical factor in any surge/mobilization expansion of your production?

Yes = 22 No = 10 DNR = 10

Has manpower, especially technical personnel, been a problem for your company in recent years?

Yes = 19 No = 13 DNR = 10

Please estimate the amount of time it would take for your facility(ies) to double production.

<6 months = 4 13--24 months = 4 DNR = 12
7--12 months = 16 >24 months = 6

Average time per company to double production = 18 months

Do you maintain "rolling inventories" for any of your defense-related manufactures?

Yes = 6 No = 24 DNR = 12

Are you familiar with the plans to develop "mobilization" weapons that could be more easily and quickly produced during an emergency?

Yes = 5 No = 25 DNR = 12

Do you think such designs could be developed for any of your product lines?

Yes = 10 No = 17 DNR = 15

Profitability

Has your financial situation been affected by the changes in the tax laws and contracting rules over the last several years?

Yes = 40 No = 1 DNR = 1

Do you believe that these changes are unfair to the defense industry as a *whole* or only certain *sectors*?

Whole = 28 Sectors = 1 DNR = 13

Have these rules negatively affected your decision to bid on some projects?

Yes = 27 No = 12 DNR = 3

Are you familiar with the new "could cost" approach to procurement being considered by DoD?

Yes = 28 No = 11 DNR = 3

Do you believe that this approach could help industry?

Yes = 12 No = 7 Maybe =3 DNR = 20

Have any of your defense-related programs been stretched due to recent service budget cuts?

Yes = 38 No = 2 DNR = 2

Has this negatively impacted your *own* financial situation and/or that of your *subcontractors*?

Own = 16 Subs = 1 Both = 18 DNR = 7

Manufacturing Technology

Has your company made substantial investments in new manufacturing/production technology in recent years?

Yes = 36 No = 11 DNR = 5

Have you participated in any of the government-sponsored manufacturing initiatives?

Yes = 20 No = 15 DNR = 7

Do you believe that any of these programs are valuable to your specific industry?

Yes = 29 No = 5 DNR = 8

Research and Development

Do you perform company-funded R&D on defense-related products?

Yes = 39 No = 2 DNR = 1

Has your investment in IR&D *increased* or *decreased* in the past five years?

Increased = 27 Decreased = 11 Stable = 1 DNR = 3

Do you undertake R&D of defense-related products under contract to the military services?

Yes = 35 No = 5 DNR = 2

What percentage of your work would you estimate is defense-related as opposed to purely commercial in nature?

0--25% = 6
26--50% = 6
51--75% = 2
76--99% = 22
100% = 6

Defense-related business as a percentage of total business per company = 71%

Air Force Association

The Air Force Association (AFA) is an independent veterans' organization whose objective is to promote greater understanding of aerospace and national defense issues. Among the ways AFA disseminates information are publication of AIR FORCE Magazine, the monthly journal of the Association, sponsorship of a series of national symposia, and the educational outreach programs of its affiliate, the Aerospace Education Foundation. AFA, however, is a grass-roots organization. Total membership is nearly a quarter million, of whom more than 31,000 are Life Members. There are 320 AFA chapters in the United States and thirty-four overseas. The Association has 275 Industrial Associates, and its chapters have established ties locally with more than 1,500 businesses in the Community Partner program. The Air Force Association was incorporated in the District of Columbia on February 6, 1946.

USNI Military Database

The USNI Military Database produces an online, unclassified database of worldwide military information, including national military organizations, strengths, and orders of battle; and technical descriptions of military weapons, sensors, ships, aircraft, and ground combat vehicles. The Database is available both online to any computer or mainframe fitted with a modem and on removable disk-cartridges for stand-alone computers. The Database is now being used by a large number of U.S. and foreign aerospace, research, and analysis firms; by several foreign governments and educational institutions; and by the news media, with disk-cartridges also being placed on board U.S. Navy ships. In addition, several hundred individuals subscribe to the Database online. The USNI Military Database is sponsored jointly by the U.S. Naval Institute, a professional association, and Information Spectrum, Inc., a studies and analysis firm.

The Aerospace Education Foundation

On May 1, 1956, the Air Force Association established the Aerospace Education Foundation (AEF). The Foundation was established as a nonprofit organization in order to formulate and administer AFA's educational outreach programs. AEF is supported through tax-deductible contributions. Over the past thirty-two years, the Foundation has made progress in educating AFA's members and the public about the critical role aerospace development plays in the modern world. By doing so, the Foundation promotes greater understanding of technological advancements and aerospace education. AEF's programs also encourage higher education in the technological career fields. The Foundation sponsors symposia, roundtables, workshops, contests, and many other programs in order to highlight the full range of educational interests of the Association and to help meet the growing need for scientific and technological expertise.

Lifeline in Danger: An Assessment of the United States Defense Industrial Base.

The Aerospace Education Foundation (1988).

AUTHORS: Norman Polmar, John T. Correll, Scott C. Truver, Robert L. Anderson

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